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PCUPGRADE

THE GUIDE TO BUILDING AND
EXPANDING COMPUTER SYSTEMS

DON'T TRASH YOUR XT!

A Rebuilder's Guide To Salvaging Old PC's

BUILD A 486 POWER STATION

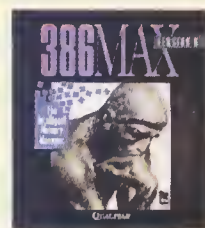
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TURN A '286 INTO A '386

Microprocessor Upgrades

- Tests of ALL the New Add-in Chips
- Installation How To's
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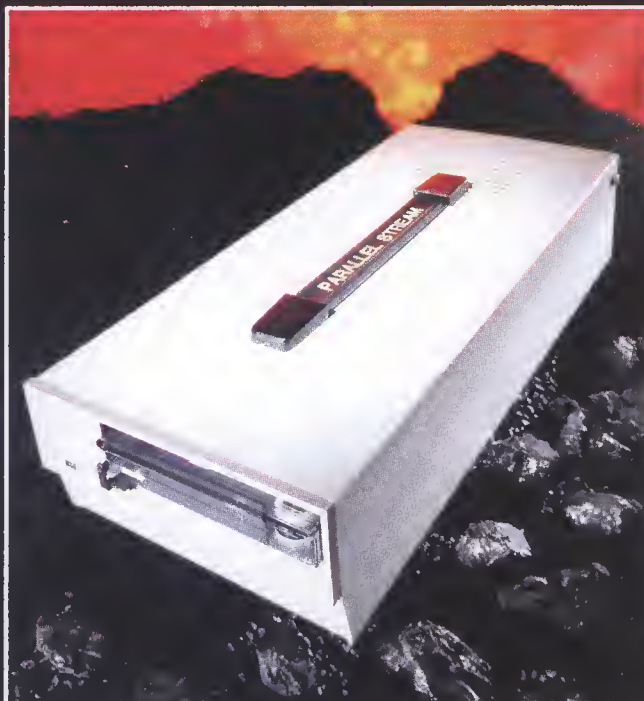
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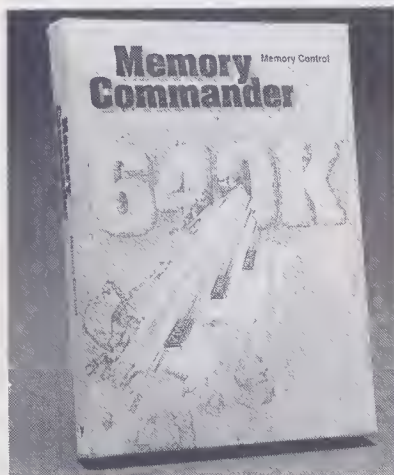
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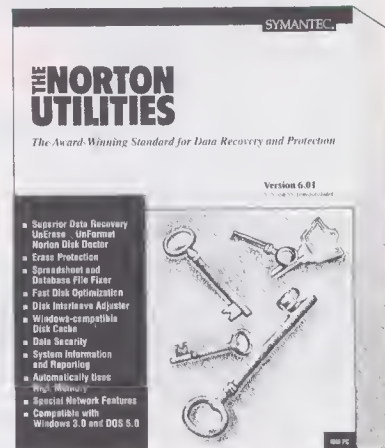
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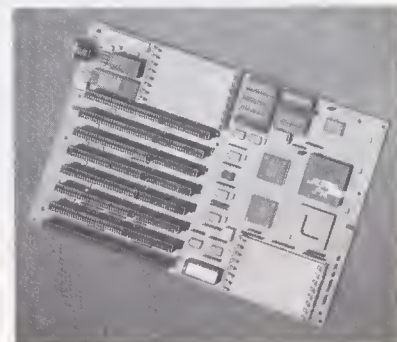
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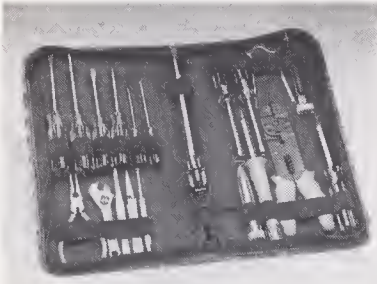
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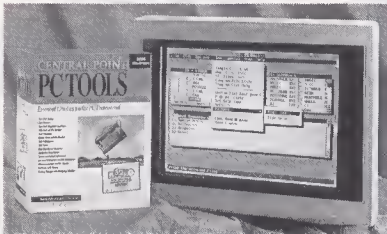


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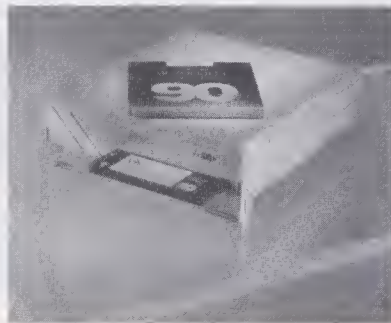
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FROM THE EDITOR

Where We Stand On Other People's Money

Saving \$125 by upgrading rather than investing in a new piece of equipment may not be significant to your business. But one of our readers found it more than significant—when it meant saving \$125 per machine for 2,000 systems.

Whether your company is in a similar situation or you're a one-person show, there's no harm in saving \$10, \$100, or thousands of dollars. Part of our credo at *PC Upgrade* is to consider our readers' budgets, large or small, in every feature article we run.

For example, while our feature on upgrading XT's and 286's makes numerous recommendations, it never shies away from giving you the best possible advice even if it means not to upgrade: "Upgrading gives you the benefit of buying components one piece at a time, but you could be limited by the weakest link in the chain."

This month the Frugal Techie talks about "the myth of the upgrade." He suggests buying a new bare-bones system and judiciously selecting components from your old setup to create something new. "Therefore, you'll save a lot of money by reusing these basic parts." As he puts it "you need to have your wits about you and plan the upgrade intelligently." Our intention: to help you keep your wits about you.

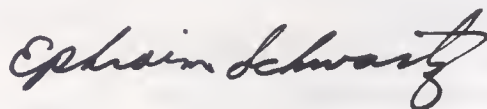
We're proud to say that we also show you how to save considerable amounts of money with simple computer and peripheral maintenance. Read our "Troubleshooting" story, which guides you through the care of all the major components and tells you how to understand and correct problems as they occur.

"Five Easy Steps to Hard Disk Revitalization" will tell how to give new life to an old drive and might even stop you from unnecessarily spending \$200 on a new hard disk.

Still another instructive article is our "Art of Hagglng" story. There are some amazingly practical tips here, from how to look uninterested instead of letting the salesperson know you're actually lusting after a new Super VGA monitor to listening in as a salesperson works with another customer. This gambit may offer some valuable insights into how a store handles discounting.

Whatever the story, whatever the advice, you can count on us never to be cavalier with your money. You'll never find us saying, "Oh, for another fifty bucks you might as well get another megabyte of RAM on your video card."

We won't advise it unless it's an important upgrade to make.



EPHRAIM SCHWARTZ
EDITOR-IN-CHIEF

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THE GUIDE TO BUILDING AND
EXPANDING COMPUTER SYSTEMS

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DISCOVER HOW THIS SMALL DIAGNOSTICS BOARD CAN REVIVE ISA, EISA AND MICROCHANNEL COMPUTERS IN 58 SECONDS OR LESS...AND IT FITS IN YOUR SHIRT POCKET!

Presenting the PocketPOST™ from Data Depot™. Created by the same engineer who originated the Award™ & KickStart™ Post Cards. This new miniature diagnostic board will help you pinpoint what's wrong with your dead computers instantly. You'll be a hero with your boss, customers, friends, and family. Make your fellow workers green with envy.

Imagine this. You're standing in front of your PC and it looks totally dead. You've switched on the power, wiggled cables, banged on the monitor, and ...nothing happens! The system won't boot and you're steaming! You're not alone. It happens to a lot of people. It doesn't matter whether you're building, upgrading, repairing or just trying to operate that computer. It's frustrating and time consuming trying to figure out why the system won't work right. Finally there's a new diagnostic product that will improve your analytical skills and make you a troubleshooting champion. Data Depot's PocketPOST™ card is a potent weapon against computers that won't work. You'll become a hero when you use it to isolate problems in mere seconds that used to take hours. Read on to find out how PocketPOST™ can make you into a technical powerhouse, boost your income, and earn you the respect of your associates.

THE POCKETPOST™ SOLUTION

Visualize the impression that you'll make with your boss, customers, co-workers and friends when you isolate problems in their computers in 58-seconds or less. They'll be amazed and they'll call you a genius. Won't that be a nice for a change?

Just in case you think that's unlikely, guess again. The genius scenario can become a reality with Data Depot's PocketPOST™ as your personal "secret weapon". It's the diagnostic card of choice for technicians and upgraders who build, repair, and sell computers for a living...or for fun.

The PocketPOST™ diagnostic card is a miniature electronic masterpiece. It'll be your "secret weapon" because in many cases nobody will know that you used it to find the problems.

Here's an example.

The dead computer is sitting in front of you. When the coast is clear you reach into your shirt pocket and pull out your "secret weapon" ...the PocketPOST™ diagnostic board from Data Depot™. Insert the PocketPOST™ card into one of the PC's expansion slots, turn the system power switch on and let PocketPOST™ go to work all by itself!

PINPOINT PROBLEMS AUTOMATICALLY

The purpose of the PocketPOST™ is to save technicians and upgraders a lot of time finding out why a system is dead. Here's what'll happen. When you turn the power on, the computer runs POST. It sends test codes to the PocketPOST™ display. You'll see LED's blinking and a digital readout displaying test codes. It's testing the power supply with a built in voltmeter, checking 9 vital circuit signals inside the computer, monitoring the system Power On Self Test (POST). If a test fails, the computer halts. PocketPOST™ displays the error code.

Look up the matching number in the PocketPOST™ User's Manual and you can determine which failing circuit is locking the system up. You've done all this in seconds, without frustration.

After the problem is isolated, pull the

"Pin down even the most elusive errors"
— Computer Shopper

PocketPOST™ card out of the expansion slot and hide it in your shirt pocket. When your boss or customer comes back, they'll wonder how you pinpointed the problem so fast. You'll get praise and appreciation.

Your boss will love you because the faster you fix computers, the more profit he makes. Maybe that raise you were hoping for can become a reality.

If you're the boss, the time you save will put more money in your pocket, so you can move on to other money making projects ...or you might

enjoy taking some time off from your busy schedule to have a root beer and go fishing ...or maybe call up an old friend. Won't that be great?

THE ROBERT HURT ADVANTAGE

One valuable fact you should know; the creator of the Data Depot™ PocketPOST™ diagnostic board is also the originator of the Award and Kickstart diagnostic boards. He's the president and founder of Data Depot, Robert Hurt, widely regarded as the guru of the diagnostic industry. So you know that years of expertise and knowledge are built into every PocketPOST™, giving you the best in features, quality and value for your investment.

FREE MANUAL... MOST COMPLETE LISTINGS IN INDUSTRY

With each PocketPOST™ board you receive the highly acclaimed Data Depot™ PocketPOST™ Manual. It's 178 pages full of troubleshooting philosophy, diagnostics hints,

"The manual is worth the price of the board alone" — Computer Shopper

and BIOS POST information. It includes 31 codes tables with over 1500 BIOS post codes from both popular and unpopular BIOSes. The PocketPOST™ manual is so complete that it has triple the information of comparable test cards. You'll save time by eliminating fumbling for the phone to call for help...you'll have all the information you need at your fingertips.

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Just in case you have questions that the manual doesn't answer, you can call toll-free for Data Depot's world-class tech support. Robert Hurt himself handpicks and personally trains the technical support staff and in fact, he occasionally gets on the tech lines to help you answer your questions. When you call for technical support, you might just be speaking with Robert himself. In any case, you get answers instead of a cold-shoulder.

HOW TO GET ONE ...OR TWO

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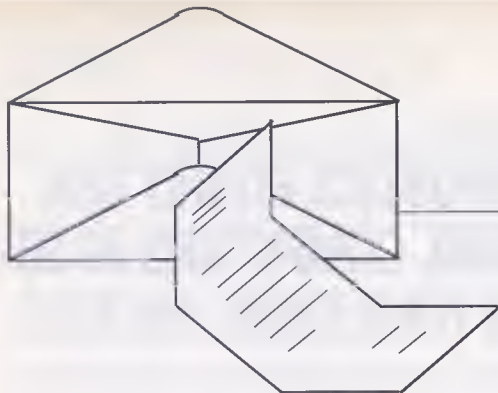
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Letters to the Editor

Grumpled on GUIs

I read your magazine regularly and find it very informative and helpful. Your editors are outstanding. I've never questioned your judgement in the past, but I found the article entitled "Pane-less Alternatives" (*PC UPGRADE* February, 1992, page 32) a bit disturbing.

In this article you tell AT users to spend \$500 or more on peripherals so they can use GeoWorks Ensemble. This is bad advice. Sure, GeoWorks Ensemble is a great program. It has the potential to do much of what Windows does, yet it runs on any MS-DOS system and uses a lot less memory and disk space. But as everyone in the computer industry knows, potential doesn't mean squat. An operating environment is useless unless there is a good supply of quality software to support it. The point of a GUI is that packages multitask and share a common interface, and files can be linked and easily copied between applications.

Not a single third party developer has written an application that takes advantage of the GeoWorks interface. Even Borland's Quattro Pro SE, mentioned in your article, does not run in the GeoWorks format. GeoWorks users can simply view Quattro Pro SE documents and cut and paste parts of them to or from other GeoWorks documents, or launch Quattro Pro SE for DOS from the GeoWorks main menu. Windows, on the other hand, has spawned hundreds of quality applications, including Word and WordPerfect for Windows, Lotus 1-2-3 for Windows, Excel for Windows, etc., etc., etc., plus many high-end desktop publishing and graphics programs like PageMaker and Arts and Letters, which ONLY run under Windows.

So what is the GeoWorks user left

with? A few inferior applications written by GeoWorks and a pretty screen full of DOS-based program icons. In reality, GeoWorks is just a program launcher.

Someone who already owns an AT is probably not interested in the GeoWorks apps, because he is probably already using WordPerfect, Lotus, dBASE, and other much better DOS-based apps. He presumably knows DOS, since he's had to use it already, so he doesn't need the pretty icons. What problem does Ensemble solve for this user? Well, maybe he can turn his kid or computer illiterate business associate on to a PC with a pretty screen. If he does want to use GeoWorks, then he should go out and buy it. It only costs about \$125 in the store and it runs on just about any configuration. But no, you tell him to go out and buy \$500 or more's worth of peripherals, so he can truly enjoy using the program. That's crazy. In a few years his AT will be worthless. Wouldn't better advice be to trade it in now and get a 386SX? If, as your article says, used ATs are selling for up to \$750, then \$500 plus the money from the sale of the used AT would be enough to buy a 386SX system with a hard disk, color VGA monitor, and Windows. Another solution would be to buy the AOX chip, or some other chip that transforms an AT into a 386SX.

Wake up folks!

Yours truly,

Alan Cooperman,
Bethesda, MD

The writer of "Pane-less Alternatives," Ron Bel Bruno, replies:

Mr. Cooperman's comments are right on the mark—it just depends what

kind of AT user you're talking about. For those users running Lotus 1-2-3 and dBase, yes, they'd be easily frustrated with the simplicity and relatively limited functionality of GeoWorks applications.

However, it doesn't take many market sales reports to show that a large percentage of home users never get near these office standards, and have no need to do so. He alternately praises and criticizes GeoWorks. This, however, is parenthetical to the larger point that he completely skirts our suggestion to replace MS-DOS with DR DOS 6.0—an operating system whose compatibility with GeoWorks is insured and endorsed by both Digital Research and GeoWorks. This combination comprises the core of an upgrade that would appeal to many types of users, both novice and more advanced.

Sure, you can go get a 386SX. But many users have no interest in frequent hardware upgrades—just like those people that hold onto a used car for several years. Instead, those steadfast auto owners opt to invest a few hundred dollars for a set of shocks, new tires, and maybe even a tape deck for Old Reliable. It's a sound strategy, and we created this story for those users.

All roads do not lead to Windows 3.1

I enjoyed my first issue of *PC Upgrade*, Vol. 1 No 1, purchased at Waldenbooks outlet Annapolis, MD. My computer is a NEC multi-speed laptop, with dual 3.5-inch floppies and operating at 4.77 or 9.54 Mhz. I've since added a Tandy RGB monitor and an Okidata printer and a Megahertz modem. I've been satisfied with my laptop, but not any more. The Multi-

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2MB	6450604	98.00
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Speed has two spaces for ROM chips but not for additional RAM. No hard disk controller. Video RAM is only 16K.

All these short comings went unnoticed until hand scanners, Windows, CD-ROM and such. Ron Bel Bruno's story "For Those Who Don't Do Windows" (PC UPGRADE, Vol. 1, No. 1) gave me hope that I could do something with my Multi-Speed that would make it possible to do DR DOS 6 and GEOWorks.

NEC Home Electronics has not answered my letter yet. Advertisers in various PC Magazines don't mention NEC Multi-Speed in their upgrade ads. Very discouraging.

Can you help or point me to someone?

Donald S. Duquet
Solomons, MD

You do have a few upgrade options. There are a number of companies manufacturing portable hard disks that connect via the parallel port. Contact a company called The Complete Portable, 505 Shawn Lane, Prospect Heights, IL 60070. Telephone number (708) 577-6342. They sell the Axouix hard disk, \$500 for 40Mb, \$700 for 100Mb \$999 for a 200Mb. Other manufacturers of portable hard disks that run off the parallel port are reviewed in this issue. Hard disks that run off the parallel port won't run as fast as an internal upgrade but this is your only option.

There's also a company called Computer Aided Technology (CAT) 101 Monroe Drive, Dallas, TX, 75229. Telephone: 214 350-0888. They manufacture a product called the CAT LPT Hand Scan Adapter. The adapter plugs into the parallel port and allows you to use any black and white hand scanner. Retail \$149.00.

Unfortunately there are no oppor-

tunities to upgrade RAM on the NEC Multi-Speed. Besides, there is no way Windows will run on the NEC V20 microprocessor.

If it's the Graphical User Interface (GUI) you want rather than Windows in particular then you should check out GEOWorks.

Notebooks and Windows 3.1 may not mix

Portable computer owners need to be wary of installing Windows 3.1 because Microsoft is supporting only VGA and higher resolution displays. Microsoft has told us that demand is heavy for SuperVGA and other high resolution video modes, so they are doing no work for the 400-line displays that were so popular for Toshiba's T3100, Zenith Data Systems Supersport 286 and Compaq's LTE286.

We urge everyone to contact their computer's manufacturer to urge support in getting Windows 3.1 drivers for the installed base.

Andrew Czernak
President
The Complete Portable

OOPS!

I want to tell you how much I enjoyed your most recent publication (Vol. 1, #2). I have already sent in the card to become a subscriber.

I also wanted to ask Mr. Gilder about his PostScript business card program. I can't seem to get it to print out. What am I doing wrong?

Gary F. Austin
Augusta, KS

*The Programmer Responds
Bottom line? It's my fault. Here's the fix.*

*Under the section heading
"% Position the card"*

*is a line that reads
18 22 translate*

*An extra line should be added after
this that reads:*

0 moveto

Sorry,
Jules H. Gilder

Building a CAD/CAM Workstation

I urgently request your help. I am in the process of purchasing a PC system, primary use as a CAD workstation. I need an educated, unbiased opinion in selecting the best components to compose the ideal system. I need your recommendation on the following: motherboard manufacturer, cache, EISA, ISA or local board design, best hard disk controller, best floppy disk drive, best monitor, video controller card...

W. J. Clark
Birmingham, AL

Sorry, we couldn't publish the entire list of what you wanted recommendations on, but we think our readers get the idea. If you're that particular about the kinds of components you want in your 486 system we recommend building it yourself! See Build Your Own Power Station in this issue and almost all of your questions will be answered.

The editorial staff of PC UPGRADE encourages your questions, ideas, and responses to our articles. Letters should be addressed to:

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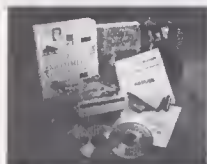
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DASH 386SX-16MHz non-cache	\$169

All DASH motherboards listed are quality American Made (except non-cache boards), featuring AMI Bios, and a full two-year warranty.

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GETTING TO KNOW QBASIC

by Gordon McComb

Since the introduction of the IBM PC in 1981, the Basic programming language has always been included with the PC operating system. In the case of the original IBM models, the bulk of the Basic language was contained in read-only memory; later versions—as well as all PC compatibles—relied on a self-contained edition of Microsoft Basic, called GW-BASIC.

GW-BASIC has long been a staple of the MS-DOS operating system, but it was phased out with the introduction of DOS 5. In its place is QBasic, a slightly pared-down version of Microsoft's phenomenal best-seller QuickBasic. QBasic is a true second-generation Basic language; gone are the ubiquitous line numbers that so cluttered programs written in GW-BASIC. The fundamental design of GW-BASIC almost forced users to write "spaghetti code"—instructions and commands that seemed to go everywhere—and caused a disorganization that greatly reduced the efficiency and maintainability of Basic programs.

QBasic, like its big brother QuickBasic, relies much more heavily on *structures*, and in fact, you can write even a complex program with-

out ever using a line number or a GOTO statement.

If you've dabbled in GW-BASIC but abandoned it because it seemed to lack direction and focus, you owe it to yourself to at least look at that QBasic has to offer. And if you've never written a computer program before, you'll be amazed at how easy it can be using QBasic.

QBasic is but a command away

If you have DOS 5 installed on your computer, QBasic is but seven key-strokes away. At the DOS prompt, just type QBASIC, and press Enter. The Qbasic editor (called the environment by Microsoft) appears. This editor is functionally the same as the DOS 5 EDIT program. If you've used EDIT, you'll be right at home in QBasic. And if you haven't used EDIT, you'll find the pull-down menus and dialog boxes a handy means to get up to speed. Though the QBasic editor uses the interface trappings of menus and dialog boxes, it is a text-based system. You do not need a color graphics adapter; an old-fashioned monochrome monitor will do just fine.

When starting QBasic you see the Microsoft copyright screen. If this is your first time in QBasic, choose the Survival Guide option (or press Enter). The screen switches to an overview of how to use the QBasic editor.

The Survival Guide is actually just a small part of QBasic's extensive On-Line Advisor system (which you can access just by pressing the F1 key). The Advisor offers context-sensitive help, and serves as the documentation to QBasic.

If desired, you can supplement the Advisor text with a third-party book on QBasic. Many are available, including several from Microsoft Press. If you already have a book or reference manual for QuickBasic version 4.5, you really don't have to buy anything extra for QBasic. On a language level QBasic and QuickBasic are almost identical. I'll talk about the major differences between the two in a bit.

The QBasic editor supports a mouse, and you may find it most convenient to use a mouse while writing and editing your programs. You can also use QBasic strictly from the keyboard; the editing keys follow the WordStar diamond-key standard, familiar to millions of computer users.

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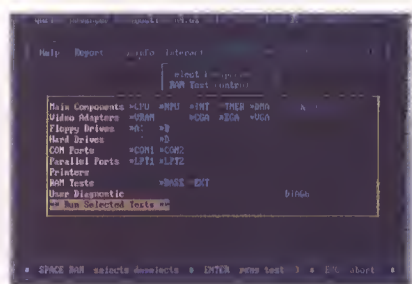


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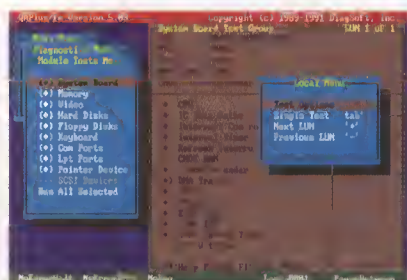
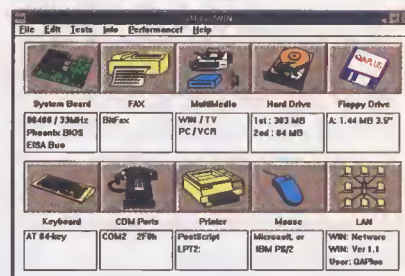


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Trying out the examples

Microsoft thoughtfully provided a number of examples with QBasic. You can access them through the Open command in the File menu. Once opened, you can review the program on the screen or Run it. Run programs by choosing the Start command from the Run menu.

Bear in mind that some of the examples require a graphics display adapter. If your computer isn't equipped with a graphics adapter and monitor, you won't be able to run those programs. But you will be able to view the programming commands that make them work. Feel free to try out all the examples you can.

If you have some Basic programming experience already, you can try modifying the programs, and trying the new version. As long as you don't resave the file you won't permanently change the disk copy. To go on to the next example, choose the Open command from the File menu again. When QBasic asks if you want to save the edited file, Just Say No.

To get the hang of using the QBasic editor, you might want to type in a short program or example. A number of magazines still print programs in Basic; find a small one and try it. Or else try the minimalist program example shown in Figure 1. It's a typical "do nothing" program, but it does serve to better acquaint you with QBasic.

What QBasic will do

If you're at all familiar with Microsoft's QuickBasic, you know that you can write programs in the QuickBasic editor, then *compile* them to create a standalone EXE program. QBasic lacks this feature. So, too, QBasic doesn't have all the advanced programming features that are commonly used when linking and creat-

Figure 1.

```

REM
THIS IS A SIMPLE EXAMPLE PROGRAM
WRITTEN FOR MS-DOS QBasic

CLS
INPUT "Please enter your name";
Name$
PRINT "Hello " + Name$
PRINT
PRINT
PRINT "This is an example of
      QBasic"
END
    
```

ing a stand-alone program. For example, QBasic doesn't let you \$INCLUDE separate programming files to create one large file.

QBasic does include most of the handy features found in QuickBasic, however. One of the most beneficial is the SUBPROGRAM/SUBFUNCTION. QBasic, like QuickBasic, forces you to write structured programs by encapsulating subprograms and functions in their own windows (Microsoft's Visual Basic, for use with Windows, uses this approach too, but takes it much further).

While you may not like the idea of being forced to write structured code, you'll be thankful for it later on. You'll find, for instance, that your programs are easier to modify and maintain when they are broken down into individual building blocks. And you'll be able to reuse routines more easily, saving you the time and energy in having to rewrite things. By separating the subprograms and functions into their own windows, you have a clearer mental picture that the routines are separate.

On the downside, the compartmentalized behavior of subprograms and functions can cause some beginning programmers headaches and heartburn, especially if you're used to the "flat" architecture of GW-BASIC program. The trouble is variables. Variables created in a subpro-

gram or function exists only as long as the program is executing that routine. Once the program returns to the main portion of the program, or branches to another subprogram or function, the variable is erased.

As you learn programming in QBasic you will find ways to work around this. At first, such a system of short-lived variables may seem awkward and limited, but in fact there are many subtle advantages to it. In fact, all of the major programming languages, such as C and Pascal, work this way. By adopting this practice for QBasic (and QuickBasic), Microsoft has taken one more step to legitimize programs written in Basic.

An option in QBasic is automatic syntax checking. Rather than tell you about all the mistakes you've made when you try to run the program, QBasic will try to warn you of problems as you write each line. The syntax checking feature, which you can disable, scans the line of code for possible errors, and flags them for your immediate attention. The error message doesn't appear until you press the Enter key or move the cursor to another line, so you aren't bothered with frivolous warnings while you type the line. You will probably find that the automatic syntax checking a godsend, and will go a long way to decreasing the amount of time you spend writing a program.

Handy features of the editor

If you've used GW-BASIC, you know what a pain it is to edit and view a program. With QBasic, your entire program is displayed as if it were a word processing document. Use the cursor keys to scan through the document and locate any specific point. Like a word processor, you can make changes and deletions without hav-

(continued on page 16)

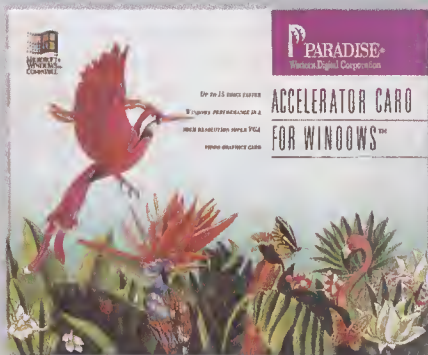
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The Software Doctor

by Robert Alonso

I use Lotus 1-2-3 version 2 at home for some after work moonlighting. Since I don't own a fancy printer, I often print my worksheets to disk as print files and take them to the office to print out on a laser printer. This used to work for me just fine until the company scrapped the old HP Laserjet in favor of a new PostScript printer. Now when I send the print files to the printer, nothing comes out. I don't know what the problem is. There are no formatting codes in the print files, just text.

*Norm Goldberg
Miami, FL*

The problem is that HP Laserjet printers can print text files without you or your software specifically telling the printer, through command codes, that what you are trying to print is text. Your new PostScript printer, however, does require some information before it can print your text files. The "PS" in the name stands for PostScript. All PostScript-compatible printers require that a header of command codes be sent to it before any text or graphics are sent to be print. Since your file is text with no header, it is ignored by the PostScript print engine. The same would happen with an Apple printer or the new IBM laser printers that come with the PostScript option installed. Your best bet is to buy a newer version of *Lotus 1-2-3* with support for PostScript printers or to try to download a new driver from a bulletin board or from Compuserve. Once you do this, you can send your

Robert Alonso is President and founder of QDIP, Inc. in Nutley, NJ. QDIP provides computer consulting and Windows and OS/2 software development services to large corporate clients.

output at home to a print file and then print it at work on the new printer. Another option is to use a utility that can print text to a PostScript printer. Version 6 of the *Norton Utilities* is one example of a utility that can print text files to PostScript printers. The name of the specific utility is: "LP." You can print a text file to a PostScript printer with "LP" by using the following command line:

LP filename.ext /PS

I just purchased a copy of MS-DOS 5.0 and installed it on my machine. The install process copied a file called HIMEM.SYS to my DOS directory and installed it in my CONFIG.SYS file. What is the purpose of this file? I have a copy in my root directory that Windows requires, but why does DOS come with it now?

*Dick Verma
Eden Prairie, MN*

The file HIMEM.SYS is an extended memory manager that is included with Microsoft Windows and DOS 5.0. Its purpose is to provide access to extended memory to applications written to take advantage of it. Extended memory is the memory located above the first megabyte of RAM. Until recently, DOS could only access the first megabyte. On 80286, 386 and 486 machines you can have as much as 16 Mbytes of memory and in some cases even more. The job of HIMEM.SYS is to work as a traffic cop and keep track of which applications have taken up different chunks of memory from the extended memory that your system is equipped with. MS-DOS 5.0 includes HI-

MEM.SYS so that in conjunction with EMM386.EXE it can load parts of DOS into extended memory and free up more conventional memory to your DOS programs. You should be careful with the two copies of HIMEM.SYS that you have on your system. Make sure that you use the one that came with MS-DOS 5.0 and not the one that came with Microsoft Windows 3.0. The HIMEM that comes with DOS supersedes the Windows version. However, if you're not using the newer Windows 3.0, save your old copy of HIMEM.SYS since Windows 386, version 2.x will not run with the new DOS HIMEM.SYS.

For more information on optimizing your memory usage, read the chapter entitled "Optimizing Your System" in the *MS-DOS User's Guide and Reference*.

I bought a clone 386 machine from a mail order ad and am very happy with almost all of its features. The only thing that disturbs me about the machine is that it came with a 3.5-inch floppy drive that always formats my floppies incorrectly and with numerous errors. At first I thought it was my disks; I had purchased inexpensive diskettes in bulk quantities. I bought a new box of 3M disks and experienced the same problem. What now?

*Leslie Martin
El Cajon, CA*

There are a couple of things that you can try. The first one is to check your floppies. Most 386 machines come with drives that can format 3.5-inch floppies to 1.44 Mbytes. You may be using double-density diskettes that can only be formatted to 720 kilo-



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386 POWER!

bytes rather than 1.44Mbyte high-density disks. If you use these disks in some 1.44 drives, DOS and the drive will try to format the disk to 1.44Mbytes, which leads to disk failures and errors. You should be using diskettes that are clearly labeled as double sided, high density. Usually, these have the initials, "DS/HD" stamped on them. The brand of diskette is less important than the rating.

If your disks are marked DS/DD, you can still use them. Format them with a parameter that tells DOS to format them to 720K. Use the following DOS command line:

```
(format a: /f:720
```

Replace the "a:" with "b:" if your 3.5 inch floppy drive is your B: drive.

If the diskettes are not causing your problem, the problem probably lies with the computer. Contact the company that sold you the machine. They will probably exchange the entire machine or the floppy drive to ensure your continued patronage.

I have been using Windows 3.0 for several months now and have not

been able to figure out how to get it to automatically load and run applications when I load Windows. What do I need to do?

Sam Harrigan
St. Louis, MO

Windows has a configuration file called "WIN.INI." This file contains many parameters Windows uses to print documents, use fonts and even configure various applications. Near the top of the file are two lines that begin as follows:

```
load=  
run=
```

These two lines tell Windows which programs to load and leave minimized at the bottom of the screen or to load and run full screen. You can put the name of the application that you want loaded or run after the equal sign, and next time that you load Windows, it will load and/or run the application. For instance, I like the clock minimized at the bottom of the screen. My WIN.INI file contains the following entry:

```
load=clock.exe  
run=
```

If you want more than one application loaded or run, separate their file names with a space. To edit WIN.INI, you can use either *Notepad* or a little known Windows program called "SYSEDIT.EXE." If you go to the File menu in Program Manager and choose the Run command you can type, "SYSEDIT" and press enter to run the tool. It will automatically load WIN.INI, SYSTEM.INI, AUTOEXEC.BAT and CONFIG.SYS into separate windows for you to edit.

When you are done editing a file, you can save the changes. This provides a quick way to edit those critical files that affect how DOS and Windows behave.

Get the prescription you need from the doctor who's always in. Write to Robert Alonso, the Software Doctor, at:

Software Doctor
PC UPGRADE
150 Fifth Ave, Suite 714
New York, NY 10011

Questions will be answered as space permits. No personal responses will be made, and the Doctor doesn't make house calls.

Putting DOS to Work *(continued from page 12)*

ing to switch editing modes, as was required in GW-BASIC.

The QBasic editor comes with a couple of handy features that makes the programming process a little easier.

- Use the Search menu to find and change text throughout the program (including in the main segment, or in subprograms and functions).
- Use the Debug menu to track down hard-to-find problems. For example, turn Trace on to follow the action of the program one step at a time. Or set a breakpoint to stop the program at a particular spot.
- Cut, copy, and paste programming

code using the commands in the Edit menu. If you have a mouse, you can drag over text to select it, then use the Cut and Copy commands.

- Print your program. You can select the current window (such as the current function window) or the entire program.

Perhaps the most attractive feature of QBasic (other than it's cost: free with MS-DOS version 5!) is that programs you write with it are 100 percent compatible with QuickBasic. This means you can develop programs using QBasic, and when you're ready, move up to QuickBasic and its advanced features. ■

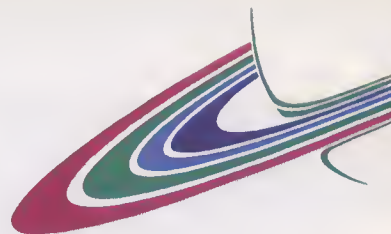
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See page 112



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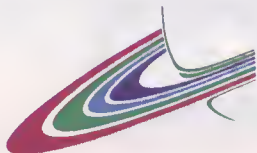
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When Disc
Problem = Read

The Hardware Doctor

by Gordon Mc Comb

EXAMINING A SICK FLOPPY DISK DRIVE

Q. Lately I've been getting error messages when trying to save and read files from my floppy drive. Old floppies, new floppies—the errors occur no matter what media I use. At first, these errors occurred only occasionally, and now they're happening several times a day. After several attempts I can usually get the computer to save or read the file, but this problem is starting to drive me crazy! What causes it, and what can I do about it?

A. Floppy disk drives are prone to a number of maladies, any of which can cause the problems you have mentioned. The drive may be dirty, or it may simply be worn out and must be replaced. And too, electronics on the drive itself, or its controller card, may be failing, which necessitates a replacement.

Let's talk about the "too obvious to mention" problems that can cause this type of error. First, be sure the floppy disks you are using really are, in fact, good. If you're using new disks, try a box of a different brand. If the problem goes away, you may simply have been the unlucky recipient of a bad batch of disks.

If you're using disks you've had a while, consider the possibility that they have somehow become damaged, or have been exposed to a strong electrical or magnetic field. Suppose, for example, that you take your disks with you to work. One day you leave them in the car. Though the day wasn't

particularly hot, the temperature inside your car exceeded 125 degrees. Over a period of hours, your disks became slightly warped and lost a bit of their shape. This is more common than you think, and it should always be the first thing you consider.

Remember too that floppy disks are susceptible to strong magnetic and electrical fields. This includes your computer's monitor, the telephone (assuming it has a mechanical ringer), hi-fi speakers, and so forth. In short, if you even think your disks were exposed to such fields, you should try a new batch that you just bought. If possible, buy a name brand.

Now let's talk about a dirty drive. Unlike the hard drive in your PC, the floppy drive is not shielded from the relatively dusty air. After a period of use—even as little as six months—a thick layer of dust can settle on the inside surfaces of the floppy drive. This dust, which mingles with the moisture in the air, has an acidic effect and can greatly impair electrical conductivity.

If such dirt is allowed to accumulate, sooner or later the drive will fail, and error messages such as "General Failure error reading drive A" will occur. Your best bet for avoiding such problems is to clean your computer, outside and in, every couple of months. Use a soft painter's brush to whisk away dirt from the cracks and crevices inside the computer. If your PC is equipped with two floppy drives, one stacked over the other, you may

want to remove the bottom one so you can clean it as well.

Airborne dust is just one way a drive can become dirty. Another way is from contamination from the floppy disks themselves. The magnetic heads of a floppy drive must physically contact the disk media in order to read and write information (this is unlike a hard drive, where the magnetic heads float a bare fraction of an inch above the disk). Over time, and a lot of disks, magnetic oxide from the disks can build up on the heads of a floppy drive. This problem is more prevalent with cheaper disks, which may not employ the manufacturing techniques that help prevent the loss of the magnetic coating.

If you suspect that the magnetic heads in your floppy drive are dirty, purchase a head cleaning kit, available at most computer dealers. Cost is generally under \$20. The kit includes cleaning solution and a cleaning "disk." Be sure to follow the directions carefully, and wait at least five minutes after cleaning before you insert a floppy disk. Waiting will allow the cleaning solution to evaporate. Should the magnetic heads be excessively dirty you may need to repeat the cleaning process two or three times.

Poor electrical contact in the connections of the floppy drive and other components inside your PC can also cause problems. You may want to carefully remove the cables and PC expansion boards inside your com-

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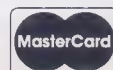
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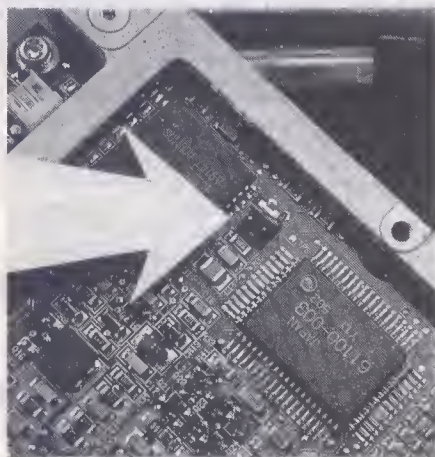
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The jumpers on the floppy drive must be properly configured in order for the drive to function properly.

puter and clean the metal contacts with alcohol. Let dry, and replace. Do one cable/board at a time, so you're sure that all the pieces go back together in their proper places. When removing cables, first note any notches or colored stripes that may denote a particular orientation. Be sure to replace the cable in the exact same way. You should have no problem if you take your time and take notes—mentally or otherwise—along the way.

If problems with the floppy drive persist, it's time to suspect the drive itself, or even the controller card that interfaces the drive to the computer's main motherboard.

The magnetic head assembly of a floppy disk drive is moved back and forth along the surface of the spinning disk by means of a stepper motor. This motor can wear out in time; also, the entire head mechanism can go out of alignment. While these individual parts can be replaced and serviced, it is usually far cheaper to simply chuck the old drive and get a new one.

Replacement drives cost about \$60 to \$75, depending on the source. You can do the job yourself, or have someone else perform the surgery. But bear in mind that the labor for replacing the drive will likely cost more

than the drive itself.

The toughest part of replacing a floppy disk drive is making sure its switches and jumpers are set properly for your computer. This includes such items as whether the unit serves as drive A or B. You may want to have the dealer preset these switches and jumpers for you, or at least show you what to do. The "manuals" that come with floppy disk drives are incredibly incoherent and technical. Physically installing the drive and hooking it up to the cables and power line in your PC is a relatively easy task.

While problems in the drive controller are rare, they can happen. If

the errors persist after cleaning and/or replacing the floppy drive, consider first replacing the cable that connects the drive to the controller. Then, if no improvement is in sight, replace the drive controller.

On some PCs, the drive controller is a separate add-in board and has the singular job of interfacing the disk drive(s) to the computer's motherboard. Replacing such a board is relatively easy and inexpensive—cost for a replacement floppy disk controller board should be less than \$35.

On the other hand, some PCs employ a dual controller board that combines the interface electronics for both the floppy and hard disk. These controller boards are much more expensive; depending on the model, well over \$100. You may want to have your existing floppy/hard disk controller card professionally diagnosed before you spend the money on a new one.

A few of the latest PCs now include the floppy drive controller electronics embedded into the main motherboard. If something is wrong with the controller circuitry, you'll need a whole new motherboard. Again, you'll want a second opinion from a dealer or repair tech before

Diagnostics

If your computer is giving you bad news about your floppy drive, you can perform the following procedures, in this order:

- 1. Try different disks**
Damaged or bad disks cause floppy drive error messages.
- 2. Clean your drive**
Airborne dust can foul your floppy drive.
- 3. Clean the drive heads**
Head cleaning kits remove magnetic oxide deposited by spinning floppy disks.
- 4. Check the electrical connections**
Poor electrical contacts = poor drive performance.
- 5. Replace the floppy drive**
Like everything, floppy drives wear out eventually.
- 6. Replace the drive controller cable**
A desperate attempt to avoid the only other possible solution, that being
- 7. Replace the drive controller**
Variously, a separate board, a dual board for both floppy and hard disk, or embedded on the motherboard. If embedded on the motherboard, you'll have to replace that: get a second opinion beforehand.

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"What's really nice about Memory Commander is that it doesn't require you to add any statements to CONFIG.SYS or AUTOEXEC.BAT." "The install program is devilishly simple."

COMPUTER SHOPPER

"...Memory Commander can provide more than 900K of conventional, real-mode memory." "...and unlike other memory managers, this one doesn't make you change AUTOEXEC.BAT or CONFIG.SYS to load TSRs and drivers high."

PC World

"When my computer now comes on line, the total bytes of memory line is no longer that aggravatingly tiny 527,000; now it comes on with the proud message: 827,392 total bytes." "What a product! How did I ever live without it?"

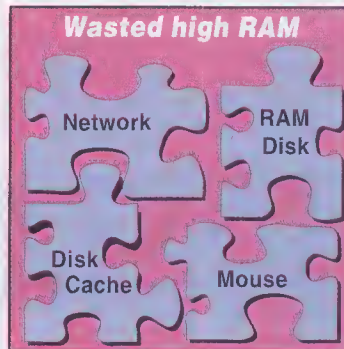
U.S. TECH

"Memory Commander from V Communications takes the ultimate step." "Using Memory Commander from V Communications, there's no fuss, no muss, and a lot of DOS."

PC Sources

"Memory Commander consistently had the most free DOS application space, providing, in some tests, over 150K more free space than the competition."

INFOWORLD



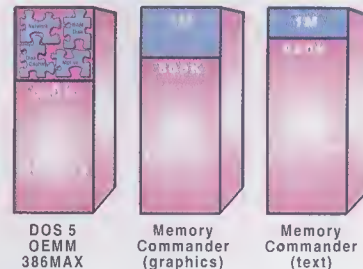
**High loading
drivers & TSRs
like puzzle
pieces that**

Even if you use QEMM™, 386MAX™, DOS 5 or any other memory manager, your PC has wasted high RAM. Memory Commander® is the only 386/486 memory manager that recovers unused high RAM and adds it to low DOS.

Memory Commander automatically loads your TSRs and Drivers and optimizes high RAM. Then, it adds the unused high RAM to conventional, low DOS; taking your system beyond the standard 640K. Low DOS can be increased to as much as 800K for running VGA graphics and 920K for running VGA text programs.

Memory Commander does all this wizardry automatically so you don't have to understand memory management. For those who like to get into the details, Memory Commander provides the simplest yet most extensive menu-based configuration of any memory manager.

Best case VGA examples



"Wow!"
PC Magazine
BYTE

Automatically provides:

Network drivers & TSRs
loaded high, above 640K

The maximum EMS and XMS
memory for your programs

The most room for large,
memory hungry programs

Substantially improved
system performance

More memory for DOS
programs under Windows

Lightning fast, DOS video
accelerator

Easy installation & optimization
for non-technical users

Memory Commander®

✓ To get more low DOS than with your current memory manager send/FAX its manual's title page. We'll send you Memory Commander for \$49.95.

✓ If you don't have a memory manager and want to start with the best, order Memory Commander for \$99.95.

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U.S.A. shipping \$6, Can & Mex \$10, Other \$18 CA res. add 8 1/4% tax. Offer subject to change. VISA/MC/AMEX

Works with all 80386 & 80486 AT or PS/2 PCs, MS or PC DOS 3.3, 4.x or 5.0 with 512K or more of extended memory. Supports MDA, Hercules, CGA, EGA, VGA & XGA video. Compatible with Windows 3.0 & 3.1, VCPI, VDS & RSIS. Provides EMS & XMS services. QEMM & 386MAX are trademarks or registered trademarks of their respective companies. © 1992

Beats QEMM.™ Guaranteed

We're convinced Memory Commander is the best. If you don't agree, return it within 60 days of purchase for a no-questions-asked full refund.



Floppy Drive/Controller Errors

Most computers perform a power-on self-test (or "POST") when they are first started. The following error codes relating to floppy drives may appear during such a self-test, or when using the IBM Diagnostics disk (or similar program). Bear in mind that the POST error codes are dependent on the BIOS used in your PC, and your computer's ability to spot problems in its peripheral devices.

Table 1 — 5-1/4 Inch Disk Drive Errors

Error Number	Problem
0600	No error (appears when using the IBM Diagnostics utility disk, or similar)
0601	Diskette/controller test failure
0602	Diskette test (PC, XT)
0603	Diskette size error
0606	Diskette verify function
0607	Write protected diskette
0608	Bad command
0610	Diskette initialization (PC, XT)
0611	Timeout
0612	Bad NEC
0613	Bad DMA
0614	DMA boundary error
0621	Bad seek
0622	Bad CRC
0623	Record not found
0624	Bad address mark
0625	Bad NEC seek
0626	Diskette data compare error
0627	Diskette change line error
0628	Diskette removed

Table 2 — 3-1/2 Inch Disk Drive Errors

Error Number	Problem
7300	No errors
7301	Diskette drive/controller test failure
7306	Diskette change line error
7307	Write-protected diskette
7308	Bad command
7310	Track zero error
7311	Timeout
7312	Bad NEC
7313	Bad DMA
7314	DMA boundary error
7315	Bad index
7316	Speed error
7321	Bad seek
7322	Bad CRC
7323	Record not found
7324	Bad address mark
7325	Bad NEC seek

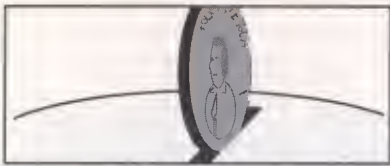
It's one thing to know what the problem is; something else to know what to do about it. Next time, the Hardware Doctor prescribes remedies for these error codes.

you replace the motherboard in your computer.

If you think your floppy drive or controller needs replacement (either by you or a professional repair tech), you may want to first use a diagnostics program, to help you pin-point the problem before you spend a lot of money on the cure.

Most diagnostics programs, like *Check-It*, require that you use a pre-formatted alignment disk. This disk is generally available from the makers of the diagnostics program, and costs \$10 to \$20. Depending on the results of the diagnostics program, you'll know if you need to replace the drive, the controller, or both. Just remember

that the diagnostics utility can't differentiate between certain errors. It's not uncommon for the program to point its finger at the controller circuitry, when in fact the problem is a dirty electrical cable connection. That's why it's important to clean everything first, then test (and possibly replace) later. ■



Ways To Stretch Your Computer Dollar

Been thinking about a new computer, but have put off the purchase because you think it'll be too expensive? While you can always pay more for a personal computer, there are many ways to pay less.

Thanks to advances in technology—not to mention furious competition—you can now buy a well-equipped business-oriented PC for less than \$1,500. And no, you don't have to visit a dusty swap meet, or send a check to some distant mail order outfit. Low prices are around the corner; you just have to know where to look.

Plus, there are numerous ways to stretch the computer gear you already have. Take a second look at that trusty old PC of yours. It may not be on its last legs after all. Give it a face-lift here and there, and you may find it'll last you a few more years.

WHAT DO YOU REALLY NEED?

You can still pay a fortune for a personal computer. There are plenty of top-of-the-line models to choose from, and at prices ranging from \$4,000 to over \$10,000. These incorporate the latest and greatest features, like super-fast processors and huge hard disk drives that can store the equivalent of not one, but three sets of encyclopedias.

These are great for some people—particularly businesses that want to use the one system as a network server and connect it to less expen-

sive workstations—but they're overkill for the average computer user. Of course, only you can decide what you really need out of a computer system, but odds are you'll do just fine with a 386 or 486 SX model. These use the industry-standard 80386 or 80486 SX microprocessor, and can run all the popular software, including WordPerfect, Lotus 1-2-3, and Windows.

Completing the basic computer system is two or four megabytes of random access memory (RAM), the stuff your PC uses to hold data while its performing its computations. RAM is laughably cheap these days; if you have a couple of extra dollars to spend, spend it on more RAM. Most 386 and 486 machines accept up to 16 megabytes. You can do well with eight megabytes (cost is about \$320 for all that memory, the cheapest and best investment you can make for your PC).

The amount of RAM installed in the computer is not a critical factor when running most DOS-based applications, even the "heavy duty" ones like WordPerfect 5.1 for DOS and Lotus 1-2-3. The situation is completely different when running Windows and OS/2 software, however. Though Windows 3.1 will run accept-

ably with just two megabytes of RAM, a minimum of four megabytes (on any computer) is highly recommended. OS/2 2.0 requires at least four megabytes, and eight megabytes is the recommended minimum.

MAD ABOUT HARD DISK REAL ESTATE

You'll also need at least one floppy drive, perhaps two, plus a hard drive of no less than 120 megabytes. You'll need this much space if you plan on using Windows, but plan for a bigger model if you'll be using OS/2, or think you'll use lots of programs.

If you need more hard disk storage space, up the ante a bit and buy a model that stores 250 or 300 megabytes of data. If you need anything more than that, you may want to consider buying a hard disk compression system, such as *Stacker* from Stac Electronics. Two versions are available: a software-only model and a plug-in card. Both let you effectively double the size of your hard disk, but at a half or one-third the cost of a larger drive.

The compression utility is designed to intercept the data before it gets to your hard drive. The data is compressed "on the fly" and stored in

a compacted form. When it comes time to fetch the data, the compression utility then reverses the process, and unpacks the information.

If you already have a PC and you're finding its hard disk filling to the brim, a hard disk compression utility is an inexpensive way to stretch those megabytes, without having to buy a new drive. Suppose you have a 250 megabyte model now and, having added Windows 3.1, plus various Windows-based word processors, data managers, and spreadsheet programs, you only have about 10 megabytes of free disk space left. You could replace that 250 megabyte model with one twice as large, but that'll cost you about \$600 or so.

A disk compression program, on the other hand, can effectively double the size of your existing 250 megabyte drive, and at a cost of about \$100. You will find that the speed of your hard drive is not affected by the compression software. While it takes a certain amount of processing time to compact the data for storage on the hard drive, there's less of it to record. The two help balance each other out, and the net result is you don't have to give up speed just to have a larger hard drive.

NOT NAME BRAND

Bear in mind that the best deals in PCs are not name brands. You'll be hard pressed to find a complete 386 or 486SX from IBM, Compaq, or Dell selling for much less than \$1,500. If you need a name brand, plan on paying a few more dollars for it.

Name brand can be an important consideration if you're in business, and you need your computers serviced. The local computer discounters—as well as cut-rate mail order and swap meet outlets—often can't provide the kind of service required by many businesses.

If computers are your forte, then you'll be able to pick apart the problems and correct for all the little glitches that can occur. There's no sense in paying the extra bucks for full-serve when you still pump your own gas. The same is true of paying full price for a PC, and never using the service that's offered with it.

On the other hand, if you treat your computer as a mere appliance—press this button and expect a letter to come shooting out of the printer—then you should carefully consider not only what you buy, but who you buy it from. You'll need the comfort and security of a full-service dealer.

Of course, this isn't to say that a name-brand computer, purchased at a full-service dealer, is embarrassingly expensive. Discounts are still provided, especially if you buy more than just the basic computer. You can find good deals on similarly equipped Dells, IBMs, and Compaqs for about \$2,000. A little more, yes, but worth it if you need it.

BUY LOCAL OR THROUGH THE MAIL

The hot trend these days is buying computers mail order. I'm all for saving money, and mail order can offer the best over-all price savings. Unfortunately, with the rise in legitimate mail order the industry has also seen a proportionate rise in the crooks. Not all of these businesses are out-and-out frauds; some walk a thin line between honesty and crookedness, and occasionally stumble to one side or another. Odds are, the more you buy mail order, the more chance you'll have of being stung.

This is not meant as an indictment against mail order. It does, however, point out the unpleasant fact that you have to be careful. Use the credit and consumer laws to your benefit. Pay by credit card and be watchful of the

charges made on your account. Keep explicit records, including all the phone calls and correspondence you make. Get names of everyone you talk to. Be sure your shipment is insured, even if you have to pay extra for it. Most mail order outfits consider it your responsibility if the goods are damaged in transit; if it's underinsured—or not insured at all—it'll be your loss.

Before shopping mail order you may want to give the local merchants a shot at your business. You may be surprised at the low-ball prices you can find. Not all of the super-duper-discount stores are listed in the phone book, especially if the book is more than a season old. Look through the paper, especially the ads in the Sunday edition.

Many communities also support regional computer-specialty newspapers and magazines. Be sure to scan through these as well.

When you find the computer you want, at the price you want to pay, don't forget the "little things," like warranty and extras. If you're comparing prices, be sure to consider these items as well. A computer selling for \$1,250, but with no warranty and no software (not even MS-DOS, which is required to even run the computer) is likely to be more expensive—in the long run—than the same model selling for \$1,400 or more.

THE MYTH OF THE UPGRADE

One way to save money on your next computer is to simply upgrade your existing PC. Unlike cars, PCs are relatively easy to enhance, just by adding or replacing components. Suppose, for example, that you current have a 286-based machine. You can upgrade that PC to a 386 simply by replacing

(continued on page 26)

Each month PC Upgrade takes a look at a unique software package to assist end users in configuring upgraded systems.

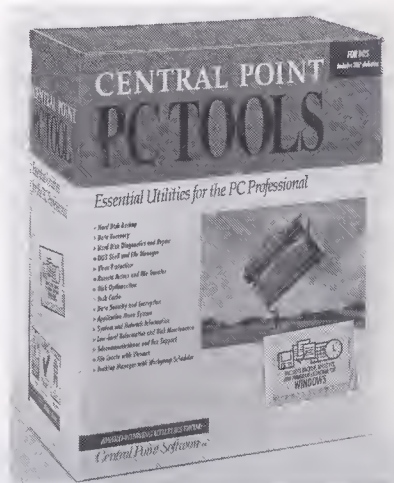
Central Point Software

PC Tools v.7.1

PC Tools from Central Point Software is a big toolbox that seemingly contains every utility that you can think of, and even some that you cannot. It starts with the *de rigueur* system information and undelete utilities and goes on and on from there.

The package covers hard disk backup, data recovery, data protection and disk maintenance, desktop organization, telecommunications, disk and file management, system and network information, remote computing, performance optimization, and data security and encryption. In addition to the DOS programs, there are *Windows* versions of several of the utilities, such as the disk backup and undelete routines. These make good use of the *Windows* user interface. What's more, most of the DOS programs can be launched from *Windows* with icons furnished. One of the *Windows* utilities supplied is a program launcher that lets you run any DOS or *Windows* program without returning to Program Manager; a nice side effect of this is that it lets you jump out of *Windows* quickly.

The backup programs are versatile and can record to various media. Data is compressed and backup speed can be up to 3.5Mb per minute with floppies or 7Mb per minute with tape. A flexible scheduler is provided that can also be used with any of the other utilities.



The data recovery utilities do undeletes and unformats, rebuild the system area of a damaged disk, and repair corrupted *dBASE*, *Lotus 1-2-3*, and *Symphony* files. Data recovery works hand in hand with the data protection/disk maintenance utilities. Their formatting can be completely reversed, and they automatically create hidden backup copies of the disk organization tables to assist recovery. Also provided are disk testing, non-destructive low-level formatting, and virus protection.

The desktop organizer utilities include calculators, clipboards, schedulers, notepads, dialers, and more—in short, everything that the busy executive could want. Included are telecommunication programs to provide E-mail, fax, and modem func-

tions. E-mail supports MCI, CompuServe, and EasyLink, while the fax program interfaces with CAS-compatible FAX boards such as the Intel Satisfaxion. The modem program is scriptable, but a standalone communications program has much more function.

The disk and file management area starts with a File Find utility that allows you to find, copy, move, delete, rename, or view files anywhere on the local computer or across a network. Viewers are provided for files in the formats of more than 30 popular applications. There is also a DOS shell that provides for point-and-shoot operation of DOS file commands and takes advantage of the same viewers as the File Find program. The shell also allows the building of customized application menus with password protection.

The system information function provides a wide range of information about the local computer and the network. Besides the usual linear progression of screens, hypertext links let you jump around in any order you wish.

A major component of the package is the Commute system, which lets you run another computer by remote control. This supports compression during file transfers and is even capable of running *Windows* with its graphic screens and mouse input. Of

course, since the bandwidth over a telephone connection is narrow, *Windows* will be very slow. However, the system will also work over LAN connections where the bandwidth is much wider, making such communication much more practical.

Performance optimization includes defragmentation, interleave tuning, and a disk cache. These have become standard in utility packages. The *PC Tools* versions work well.

The final area is data security, which includes the ability to lock directories, write-protect portions of the disk, erase files to Department of Defense (DOD) standards, and encrypt files with the U.S. National Bureau of Standards' Data Encryption Standard (DES) algorithm.

Documentation for the package is excellent, with one minor proviso. The eight books would be far easier to use if there were one complete index. The installation goes well, though it takes a long time; there is a lot of

software here. Installation itself is simple: You are given the option to install the entire package or any part(s) thereof, and then just feed diskettes as they are needed. All diskettes (8 3.5-inch or 15 5.25-inch) have unique names and numbers. The disks are called for in order, and each disk is used only once. After loading, there are a few configuration screens, after which the program is ready to run. At every point in the installation process, there is clear and complete on-line help for almost any questions that you might have.

The user interface is made up mostly of menus and is well laid out, if a little fussy. (It seems to be standard to have this sort of look to a broad utility package these days.) There is a definite family resemblance between all the programs, but it is difficult to distinguish the look from other packages in this genre. In addition to the menus, the utilities can all be called (by typing in parameters)

from the command line. Doing so is best suited to batch files, as the program parameters are complex; you won't want to type all those codes every time you call a file.

Overall this package is very thorough, and will cover the needs of almost anybody working with a personal computer. The only thing that seems to be missing is a disk sector viewer and editor. It is quite reasonably priced, considering how much is provided. *PC Tools* will probably change the way that you work, because it is likely to introduce you to new forms of utility software that will make life easier for you.

Note that the previous version of *PC Tools*, v. 7.0, was rumored to be full of bugs, rendering the software barely usable in many cases. Version 7.1 was released in October 1991 and was sent free to registered 7.0 users. We found no bugs in the latest version and the general consensus is that the bugs have been repaired. ■

Price: \$179 **Requirements:** IBM PC, XT, AT, PS/2, or compatible with 640K RAM, MS-DOS 3.0 or higher, high-density 3.5-inch or 5.25-inch floppy disk drive, and hard disk with 6.8Mb free. *Windows* applications require 2Mb RAM and Microsoft *Windows* 3.0 or higher **Company:** Central Point Software, 15220 N.W. Greenbrier Pkwy., Beaverton, OR 97006, (800) 445-2110, (503) 690-8090

(*FRUGAL* continued from page 24) the microprocessor chip with a "386-on-a-card" (Note: you can't merely exchange the processor for the next higher model).

While all this sounds great in theory, in practice upgrading a PC in this fashion can be more expensive than buying new. With today's prices, it's not unusual to find new PCs for less than the cost of upgrading. This isn't to say upgrading is a bad idea. But you need to have your wits about you, and plan the upgrade intelligently.

Instead of upgrading your existing PC, buy a new "bare bones" model that consists of nothing more than the motherboard (with RAM), the power supply, and the case. Now dismantle your existing PC for its parts. The biggest changes in PCs have been in the motherboard; the floppy drives, hard drives, and other components haven't changed as much. Therefore, you'll save a lot of money by reusing these basic parts. For example, assuming that you can re-use everything from your old PC, you can up-

grade your computer from a 286 to a 486 SX for less than \$350. Such an upgrade isn't a "half-way" measure, either. You get a full 486 SX, not a 286 that's been coaxed into thinking it's a 486.

Of course, while you're stripping your old PC, you'll want to think about bettering the components. Maybe you'd like a higher resolution monitor, for instance. Or perhaps you'd prefer to sell your existing 150 megabyte hard drive and purchase a much larger model. ■

The Art of Haggling

So they call you a cheapskate. It's still worth a try!

You have your eye on that sporty new PC clone that just came in at the computer store. It comes with everything you want: gobs of memory, hard disk, high-resolution color graphics, enhanced keyboard—you name it, it's got it. But it also has a price tag higher than you can afford. You've finally found your dream machine, but the bucks aren't there to take it home.

Time to give up?

Not yet. Granted, we Americans have largely lost the art of haggling—the not-so-subtle approach to bargaining for a lower price. In our country it is not customary to dicker over professional services like the doctor's bill or the accountant's fee, or even over fixed-price goods like gas and groceries. But it's still acceptable to haggle over certain discretionary products. And that includes computers.

There is little risk you'll insult your computer dealer if you ask for a lower price. That is part of your job as a savvy consumer. While the dealer may seem put out, and may argue that accepting your bid will drive him out of business, that is part of *his* job as a savvy merchant. As long as you haggle in honesty, the odds are good that you'll arrive at a price you'll be willing to pay and that the dealer will be willing to accept.

Where to Haggle

Some parts of the country are more used to haggling than others. Bargaining is common in larger cities, particularly New York and to a lesser extent Los Angeles and Chicago. You'll have better luck there than in small communities, where the computer dealer may be forced to sell at or near full retail to make up for low volume.

Sometimes it pays to drive to a nearby large city so you can take advantage of the lower prices and the increased opportunity for haggling. A personal visit is mandatory: You cannot haggle by phone.

You'll also find that haggling is definitely not welcome in the chain stores such as Egghead, Software Etc., CompUSA and—especially—Radio Shack. Most often the prices at chain stores are set by the home office, and the sales people are not allowed to change a price without prior approval. Indeed, at Radio Shack the sales force is warned that lowering the price to make a sale can lead to dismissal.

This doesn't mean that sales people at the chains can't make deals. While they may be forbidden to reduce the price, they may be able to sweeten the pot by throwing in extra items or services. A common extra proffered by some chains—but usually only

when the sale seems to be slipping through their fingers—is a free extended warranty. Depending on the terms, this may be worth several hundred dollars and may in fact come in handy some day. Consider it carefully.

Snoop Around and Don't Look Too Interested

When you arrive at the store, check out the merchandise and zero in on the computer or other goody you want to buy. Avoid looking too eager to spend your money. If approached by a salesperson (and this should happen within a couple of minutes in a decent store) shrug off the first offer of help with an "I'm just browsing".

If there are other customers in the store try to listen in on the conversation. Is anyone else haggling? What is the response? If the salesperson refuses the lower bid and adheres to the sticker price, the store may not be fertile ground for haggling. Move on the greener pastures.

Look for prices. Many computer stores don't post prices on the bigger-ticket items such as computers, printers and monitors. You have to ask. If prices *are* displayed, ask if the model you are interested in is currently on sale. Or you can phrase it, "Is this

your best price for the Flummery X01 printer?" or "What is your best price on . . . ?" This puts the salesperson on the defensive and signals that you are a price-sensitive shopper. The salespeople at most computer stores are paid on a commission basis, so they are very interested in clinching the sale even if it means dropping the price a few bucks.

Some stores have an unposted policy of firm prices for major hardware items such as computers and printers, but offer greater flexibility on add-ons and software. If you are buying a complete system from one dealer you might have to pay regular price for the basic computer but you may be able to slash dollars on all the extras. Depending on what you buy you could save several hundred dollars. This is especially true if you are stocking up on software. At the very least, by the way, your PC should come with MS-DOS 5 and perhaps even Microsoft *Windows* 3.1; these should not be considered "extras".

In the course of bargaining you will soon get a handle on where the price is most sensitive and where you can concentrate your haggling skills.

Careful Negotiation

Once the dealer's initial price for an item has been established, the haggling begins. But don't be too quick to counter with a lower bid. Instead, nod your head pensively and pretend to think about it. Return to the item and look it over again, weighing the cost against its features.

Decide what you are really willing to pay, and quickly calculate the difference between that price and the dealer's offer. For example, if a printer is tagged at \$675 but you want to pay only \$625, the difference is \$50. Your opening bid should then be \$50 less than the amount you want to pay: \$575. That leaves room for ne-



Drawing by Erica Brown

gotiations.

If you are extremely lucky, the dealer will accept your opening bid, and you'll have got the printer for even less than you were willing to pay. More likely than not, however, the dealer will refuse the bid, but will indicate that he's willing to shave off a few dollars and accept, say, \$650. And this will go back and forth either until you are unable to strike a deal or until the dealer accepts your final offer.

There are obstinate dealers out there whose idea of tough negotiating is to turn down all your offers, however reasonable. Haggling may indeed be pointless—some dealers consider their prices so low that bargaining is unwelcome—but you can only find out by trying. If a dealer rejects three offers you can be pretty certain that your attempts to haggle are futile.

After a price has been settled, do not try to renegotiate it subsequently. The worst thing you can do is to try to lower the price after a successful haggle. Don't gloat over your victory and assume that because you chiseled off a few dollars you can chisel off a few more. You'll anger the dealer and may cheat yourself out of the chance to make a good deal on other things you want to buy.

The Art of Compromise

As you can see, haggling is really

negotiating, which in turn is basically reaching a compromise. If a dealer is willing to reduce the price for an item you may be asked to accept less than the complete package. While you should expect a completely functional piece of hardware or software, you may be able to cut the price by agreeing, for example, to forgo the normal in-house customer support service or training. This isn't a great loss if you are familiar with computers and can get the product up and running without the dealer's help.

It goes without saying that you should always get the regular manufacturer's warranty. The dealer is generally obliged to pass this along in any case. But note that some computers are actually sold sans warranty; this enables the dealer to buy the goods for less and thus to offer a better price.

Be sure to check that whatever you are buying comes with a warranty. At a minimum this will include a printed warranty card and a registration form. If your purchase lacks these items and if the dealer refuses to give them to you ("Don't worry: the manufacturer will make good on any problems"), it's a good bet that you aren't covered by any warranty.

Another way you can expedite the haggling process is by arming yourself with newspaper ads or prices from competitors. Explain that you've found other dealers offering the same item for less, but you'd prefer not to do business elsewhere, citing better sales staff and support—or any other compliments you can think of. More and more computer stores are adopting the "We'll match any advertised price" policy, even if this is not posted.

The computer biz is a highly competitive one, after all, and the store that will haggle with its customers—and make the sale—is more likely to be around next year. ■

It's All Happening at the Swap Meet

And here's a list of upcoming computer shows and swap meets

June 6, 1992

ATC Productions Computer Show & Sale
Dallas Area
Plano Center
2000 W. Spring Creek Parkway
214 637-4532

Swap Meet
Willow Grove, PA
George Washington Conference Center
PA Turnpike, Exit 27, Left after Toll, Just ahead on right
800 631-0062

June 7, 1992

The Vallejo Computer Show & Sale
Solano Co. Fairgrounds
Exit Hwy. 37 off of I-80, across from Marine World
800 344-3773

June 13, 1992

Edison, NJ
Raritan Center Expo Hall
NJ Turnpike Exit 10 to Route 514 West
800 631-0062

June 14, 1992

The Sacramento Computer Show & Sale
Sottish Rite Temple
6151 H Street
From I-80m exit H St, right on H to location,
corner of Carlson & H. From Hwy 50, exit Howe Ave. North. North on Fair Oaks, cross river and it is 2nd building on right.

June 21, 1992

The Santa Rosa Computer Show & Sale
Sonoma County Fairgrounds
Exit Hwy. 12 East off Hwy. 101
800 344-3773

The San Diego Computer Show & Sale

1895 Camino Del Rio South,
Exit Mission Ctr. off I-8
800 344-3773

June 28, 1992

ATC Productions Computer Show & Sale
Houston TX
J.W. Marriott Convention Center
5150 Westheimer
(214) 637-4532

The Hayward Computer Show & Sale

Centennial Hall
22292 Foothill Blvd
I-580 to Hayward 238 exit, left on City Center Dr.
800 344-3773

July 12, 1992

The Sacramento Computer Show & Sale
Sottish Rite Temple
6151 H Street
From I-80m exit H St, right on H to location,
corner of Carlson & H. From Hwy 50, exit Howe Ave. North. North on Fair Oaks, cross river and it is 2nd building on right.

July 18, 1992

Parsippany, NJ
Aspen Manor
Route 46 Westbound, Near I-80, I-287 and I-280- Route 80 Westbound, Exit 47, Past Wendy's

July 25, 1992

Swap Meet
Melville, New York
Huntington Hilton
Long Island Expressway Exit 49,
South 1 mile on right on Rte 110
800 631-0062

The Vallejo Computer Show & Sale

Solano Co. Fairgrounds
Exit Hwy. 37 off of I-80, across from Marine World
800 344-3773

July 26, 1992

The Hayward Computer Show & Sale
Centennial Hall
22292 Foothill Blvd
I-580 to Hayward 238 exit, left on City Center Dr.
800 344-3773

The San Diego Computer Show & Sale

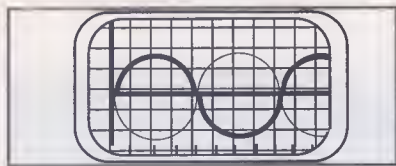
1895 Camino Del Rio South,
Exit Mission Ctr. off I-8
800 344-3773

August 8, 1992

Marlborough, MA
Royal Plaza Trade Center
I-495 Exit 24-B North of Mass Pike, about 6 minutes - 1 Mile right on Rte. 20
800 631-0062

August 9, 1992

The Sacramento Computer Show & Sale
Sottish Rite Temple
6151 H Street
From I-80m exit H St, right on H to location,
corner of Carlson & H. From Hwy 50, exit Howe Ave. North. North on Fair Oaks, cross river and it is 2nd building on right.



by Hillary Rettig

MEMORY MANAGEMENT SOFTWARE

"Out of memory."

"Insufficient memory to run application."

If you're lucky, you'll get one of the above error messages if you bump up against your PC's RAM limit. If you're not so lucky, your system will hang, leaving you no choice but to reboot, possibly losing data or corrupting files in the process. Along the way, you may notice that, as your datafiles grow in size and complexity, your heavy-duty spreadsheet, database, DTP, and other programs slow to an exasperating crawl.

Running out of RAM, or "RAM cram", as it's popularly dubbed, is a condition that afflicts many, if not most, PC users. Sometimes just an annoyance, at other times it's a serious hindrance to productive work. In the "old days"—say, five years ago—it wasn't such a problem: back then, most people ran one application at a time on relatively "vanilla" computing platforms. These days, however, the average computer user is likely to be running not only his or her main application, but a flock of device drivers (special programs designed to run complex hardware, such as video or network cards) and memory-resident software ("TSR's"—Borland's Sidekick being a popular example) at the same time. All of these programs take a bite out of your precious RAM reservoir, leaving less room for your main programs and their correspond-

ing data files.

The answer to RAM cram is not simply to rush out and buy more RAM: you can plug a magnificent 64Mb onto your 80386 motherboard, but if it's not configured properly—i.e., configured in the way your applications require—you have a good chance of getting the same "out of memory" messages as your neighbor with only 640K. Your first step in curing RAM cram should therefore be to install an inexpensive (less than \$100) memory management program. This program will make the maximum amount of RAM available to your programs—and once you've installed it properly you may discover that you don't need to add more memory at all.

"Memory management" is one of those catchphrases that strikes fear into the heart of computer novices, but it shouldn't. While the technology is arcane and the terminology tricky, you don't need a Ph.D. to learn how to manage your memory effectively. Most modern memory managers now have good manuals and "automatic" modes suited towards beginners: as long as you're careful and keep backups (particularly of your CONFIG.SYS and AUTOEXEC.BAT files), you can't do any lasting harm. However, to install and use a memory manager properly, you need to know a bit about what's going on under your

machine's hood.

Today's RAM cram problems are the direct result of design decisions made ten years ago, at the birth of the PC. The original IBM PC, some may recall, was based on an 8088 microprocessor that could only use up to 1Mb of RAM—then considered a whoppingly generous amount. The bottom 640K of that RAM (what we now call "lower" or "conventional" RAM) was allocated for programs (including DOS); while the high RAM region between 640K and 1Mb was reserved for the PC's built-in hardware-related code (for example, the code controlling video). Intel's next generations of microprocessors, the 80286 and 80386, could use up to 16Mb and 32Mb, respectively; however, because the 641-to-1024K region continued to be reserved for hardware code, the 640K lower RAM ceiling remained fixed. This lower RAM region is where the traffic jam of RAM cram occurs—every program you use will try to draw its RAM from this limited pool, unless you use a memory management program to make other RAM available to it.

Users of different generations of PCs have different options: Because 8088- or 8086-based PCs can only use up to 1Mb of memory, owners of these computers will have only limited upgrade options. Those with the right hardware may be able to use

Quarterdeck's program QRAM or 386MAX (see reviews, below), the only popular memory managers for 8086, 8088, and 80286 machines, to load parts of some of their programs "high" (i.e., move them from the bottom 640K to the upper 384K of RAM, thus freeing up more of your precious lower RAM). In special circumstances, QRAM can even raise the 640K ceiling by up to 96K. Another very effective enhancement for 8088 and 8086 users is to upgrade to DOS 5.0, which uses much less RAM than previous versions.

Users of 80286-based PC's have more options. As with the 8086/88 machines described above, they can use QRAM to load programs high. However, they can also add up to 16 Mb of RAM to their machines. The portion of this memory above 1Mb (technically above the 1088K that comprises both the lowest 1Mb and the 64K High-Memory Area, or HMA, directly above it) is called extended (XMS) memory; applications written to conform to the Lotus-Intel-Microsoft (LIM) specifica-

tion—notably Lotus 1-2-3 and Windows—can access that memory and use it to supplement the lower 640K. Adding RAM chips to provide more XMS memory is a good investment if your programs can take advantage of it. (Note: XMS memory can also be used to create a disk cache or RAM disk—two devices that let you copy data and programs from relatively-slow hard disks to faster RAM memory. Consult your software manuals to determine the best use for your machine's RAM.)

Although adding XMS memory is a good way to make more RAM available to those programs that can exploit it, most DOS-based programs are not equipped to do so: they require a special type of memory called expanded (EMS) memory in order to break past the 640K ceiling. If your PC is 80286-based, you can add special expanded memory boards (for example, the AST Rampage Plus) to provide EMS memory; owners of 80386 and higher machines are luckier, since the ability to switch between XMS and EMS memory is

built right into their microprocessor. They need only use an inexpensive memory management program (or DOS 5.0) to configure their RAM optimally for any assortment of DOS programs.

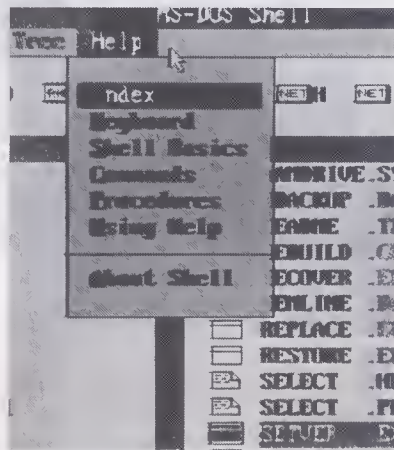
The 80386-level memory managers reviewed below all offer assorted tricks for maximizing the amount of RAM available to your applications. Most let you load small programs and device drivers high. Most also let you configure memory above the first megabyte as either XMS or EMS, depending on your programs' requirements. The memory management programs vary in the number and precision of the tools they offer, and also in the amount of expertise required to use them properly. Begin your quest for the ultimate 80386 memory manager with DOS 5.0: while its tools are not the most sophisticated on the market, they may be adequate to your needs, and the program itself has enough other fine features to make it a worthy investment for even the most frugal computer user.

REVIEWS

DOS v.5.0 Microsoft Corporation

No matter what kind of system you're running, DOS 5.0 should be a cornerstone of your memory-management efforts. Not because its memory management capabilities are the most sophisticated reviewed—they're not—but because its memory "footprint" is much smaller than that of its predecessors. Upgrading to DOS 5.0 is one of the quickest and easiest ways to open up substantial amounts of lower RAM to your applications.

Just how much RAM you'll reclaim will vary. Microsoft estimates



at least 45K—however, it could well be more, particularly if you upgrade from one of the bloated 4.x versions. (DOS 5.0 requires as little as 19K of lower RAM—leaving up to 621K available for your applications—compared with 65K for DOS 3.3 and 75K for DOS 4.01.)

DOS 5.0's memory management features center around an extended memory manager, HIMEM.SYS, that provides access to your extended memory and high memory area (HMA), and an expanded-memory

manager, EMM386.EXE, that allows the XMS memory provided by HIMEM to emulate expanded memory (EMS), according to the Lotus-Intel-Microsoft (LIM) specification. These work essentially the same way as their equivalents in the other 386-level memory managers reviewed here, although in general there are fewer features and customization options here, and—perhaps because of the absence of bells and whistles—the memory gain after installing the programs is less.

DOS 5.0 does have one serious shortcoming relative to the other programs reviewed: the lack of an automatic memory setup program, such as QEMM's Optimize. This means that you must set up your memory configuration manually—a daunting task for beginners. The DOS 5.0 manual offers some guidance, and there is also MEM, a utility that tells

you what memory your machine has available and which programs are using it. (DOS 5.0 lacks a full-fledged system information program on the order of Manifest or ASQ.) Still, novices and busy people, while still installing DOS 5.0 for its low overhead and numerous other benefits (see below), may wish to look towards another memory-management solution.

DOS 5.0's installation is reasonable painless, for such a dramatic upgrade. The program can only be installed from your A: drive, so make sure you buy a package with the correct size media.

There are also incompatibilities between DOS 5.0 and certain applications: make sure that you read DOS's README file to see if there's a conflict before you install the program. If any of your applications mysterically stop working after in-

stalling DOS 5.0 you may want to look up DOS 5.0's SETVER driver and command. The DOS 5.0 manual appears to be a total overhaul from previous versions—you'll be surprised to discover that it's both readable and well organized.

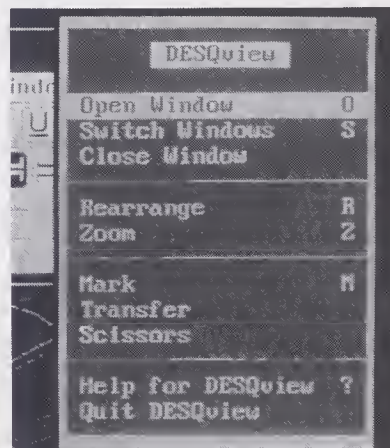
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With its combination of lowered RAM overhead and superior features, there is no reason not to upgrade to DOS 5.0.

Price: \$99.95 (upgrade price) **Requirements:** Runs on all IBM PC's with at least 256 Kb RAM and running DOS 2.11 or higher. **Company:** Microsoft Corporation; One Microsoft Way; Redmond, WA 98052-6399; (800) 992-3675

QEMM-386 v. 6 Quarterdeck Office Systems

Quarterdeck's QEMM-386, the best-selling memory-management program on the market, has always distinguished itself by its ease of installation, stability, and the number and quality of its accessory memory-management tools. Version 6.0, released last year, not only frees up significantly more lower RAM than previous versions, but also includes enhanced Windows 3.x support and the unique "Stealth" technology that swaps unused ROM BIOS code in and out of RAM. QEMM-386 also now supports the advanced memory-management features found in Chips & Technologies LEAP, NEAT and SCAT chipsets, as well as Compaq-



style "top memory" and the "Suspend/Resume" power-saving feature found in many laptops. Finally, those

with microchannel-bus (MCA) PS/2 computers will appreciate QEMM-386's internal library of RAM and ROM addresses for many of the most common MCA add-on cards—a feature that aids in resolving memory conflicts.

Installing QEMM consists of little more than typing two commands: "Install" and "Optimize". The Optimize program sorts through the contents of your AUTOEXEC.BAT and CONFIG.SYS files in order to discover programs, device drivers, and buffers to load into high memory. My own experiences, as well as those of other computer professionals I consulted, indicate that Optimize will

take your computer about 90% of where it can go in terms of memory efficiency: a bit of manual tweaking is needed to perfect the fit. (Memory gurus will be pleased to know that there are more than sixty command line parameters to aid in configuring QEMM-386 to your system's exact needs.) However, for most people, Optimize's results will more than suffice. (N.b.: QEMM's widely-touted "Stealth" ROM technology only liberated a disappointing 3K RAM on my test machine. Users on BIX and other bulletin boards are reporting gains of up to 20 or 30 Kb, however—your mileage, as they say, may vary.)

QEMM-386 comes with a host of auxiliary programs designed to meet certain specialized requirements. If you have EGA or VGA capabilities, and would like to make more RAM available for text-based programs such as dBase, you can use the VIDRAM program to disable your graphics and make the resultant freed RAM (96K, in some cases) available for your program. The group of programs QEMM-386 calls its "DOS Resource Programs" (BUFFERS.COM, FILES.COMM, FCBS.COM, and LASTDRV.COM) lets you load the eponymous DOS resources into high memory. In a "typical" system whose CONFIG.SYS file contains

the lines BUFFERS=30, FILES=30, and LASTDRIVE=Z, proper use of the QEMM DOS Resource Programs can reclaim about 20K of lower RAM.

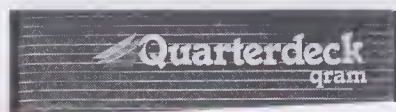
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The QEMM-386 manuals are clear and helpful and contain up-to-date information about DOS 5.0.

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GRAM v. 2.0 Quarterdeck Office Systems

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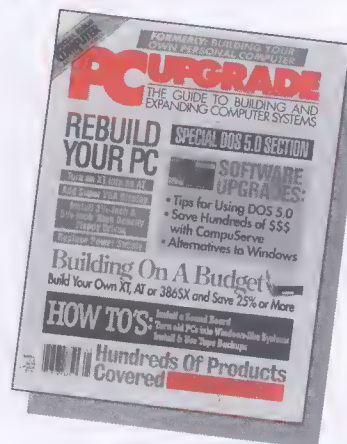


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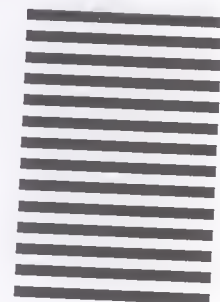
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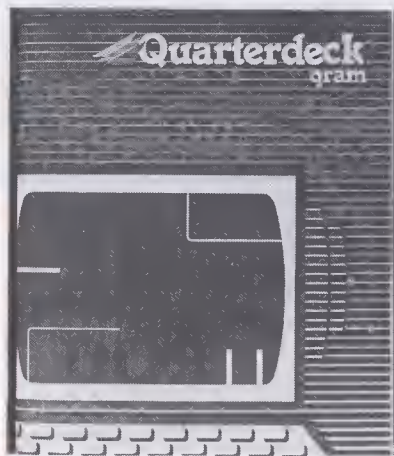
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GRAM v. 2.0 Quarterdeck Office Systems

Quarterdeck's GRAM (pronounced "cram") is the only product in our lineup designed specifically to work with 8088, 8086 and 80286 microprocessors. It offers two methods for optimizing your available memory: it can (1) help you load programs and drivers "high" (i.e., into the upper RAM region between 641 and 1024K), and (2) raise your conventional memory ceiling by almost 100K (to 736 Kb).

Interested? Who wouldn't be? However, there's one important caveat: GRAM only works with PC's with EMS 4/EEMS expanded memory (provided, for example, by an expanded memory board such as the AST Rampage Plus or BOCARAM/AT Plus) or a Chips & Technologies NEAT chipset. (To find out if your computer qualifies, check the manuals that came with your motherboard



and memory board, or with the manufacturer.) Finally, be aware that you really need more than 640K RAM to get the most out of GRAM: those with only 640K may be able to use the program to raise their conventional memory ceiling, but ONLY if they have an EGA or VGA graphics

card installed, and ONLY if they are using applications which do not require graphics. (Quarterdeck has produced a program, QTEST, to determine whether your system has untapped memory that might be available for use by GRAM. QTEST is available free on popular BBS's such as CompuServe, or from Quarterdeck's own BBS: you can—and should—download and use it before investing in GRAM.)

Like big brother QEMM-386, GRAM is a collection of programs and device drivers designed to handle different memory management tasks. The two most important are the GRAM.SYS and QEXT.SYS device drivers, which are extended memory (XMS) managers. Both are installed into your CONFIG.SYS file and are activated upon boot-up: GRAM redefines some of your expanded or

shadowRAM memory (provided by the chipsets mentioned above) into simulated High Memory into which you can load programs and drivers, while QEXT works on the remaining memory to produce extended (XMS) memory for programs that need it. Other programs in the QRAM package include LOAHDI, which loads programs high into the memory area created by QRAM and VIDRAM, which disables EGA and VGA buffering and makes the recovered

memory available to programs (such as dBASE) which do not require graphics.

Again as with QEMM-386, QRAM's Install and Optimize programs make installation painless, even for beginners. Install copies the QRAM files onto your boot disk, while Optimize analyzes the contents of your AUTOEXEC.BAT and CONFIG.SYS files to determine the optimal use of QRAM's device drivers, and then adds those drivers to

your CONFIG.SYS and AUTOEXEC.BAT files. The results arrived at by Optimize should be fine for all but the most finicky users; however, the QRAM manual also offers many tips for those who want to fine-tune their QRAM setup to get the most out of their available resources.

The QRAM package also contains a copy of Manifest, Quarterdeck's excellent system-information program (described in greater detail under the QEMM-386 section).

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386Max v. 6.01 BlueMax v. 6.01 Qualitas, Inc.

386Max and BlueMax are Qualitas' memory managers for IBM-clone and "true blue" PS/2 machines, respectively. They offer more features than major competitor QEMM-386 and offer the potential for a greater memory boost. I did, though, find 386Max a bit more finicky than QEMM-386.

Both 386Max and BlueMax offer a comprehensive set of memory management tools, including a high memory manager, extended memory manager, expanded memory emulator, and special utilities for remapping EGA and VGA graphical code and for swapping ROM code in and out of RAM as needed. Like QEMM-386, 386Max is able to reconfigure memory "on the fly", according to the needs of the applications you're running, and like QEMM-386, once you get 386Max running, you can essentially forget about it. Unlike QEMM-386, however, 386Max can also manage memory on 8088- and 80286-based PC's equipped with NEAT, AT/386 or LEAP Chips and



Technologies chipsets, making it an upgrader's bargain. The 386Max package also includes a hard disk cache program, adding to its value. 386Max freed an impressive 619K and 635K of conventional memory, respectively, on the two PC's I tried it on. (In both cases, the amount freed was higher than QEMM-386 was able to provide.) However, whereas one 386Max installation went smoothly, the other did not. In the latter case,

the Maximizer automatic-configuration program failed not once, but several times, forcing me to delve into my boot-up files and configure the program manually. (This was a 386/33 with an AMI BIOS running PC-Kwik cache, the Stacker disk-compression utility, an ATI Ultra video card, and an Intel Satisfaxtion card.) Although my experience is probably not typical of 386Max users, this program was the only one out of those reviewed to display any problems. Configuration problems aside, 386Max offers several features that beginners in particular will enjoy, including the MAX shell that offers a menuing interface for the program; a "strip" command that can return your boot-up files to their original pre-386Max state, if needed; a "refresh" command that lets you redo your 386MAX installation to accommodate hardware and software changes to your system; and a program that enhances the HELP command in DOS 5.0 to incorporate

386MAX-related information. The ASQ systems-information utility, while less polished than QEMM's Manifest, includes a well-written tutorial and context-sensitive explanations of the various information screens.

Power users, too, will appreciate 386Max's "extras". The program supports the DOS Protected Mode Interface (DPMI) DOS-extender standard,

a new technology that will offer more conventional memory to those applications written to conform to it. (As of now, Lotus 3.1 is the only major application doing so; however many other programs are currently in planning.) 386Max also offers superior TSR support, particularly within Windows: it not only lets you load TSR's (memory resident programs) into high memory from within Win-

dows, freeing up more lower memory for Windows itself, but also lets you run multiple TSRs in separate Windows windows—a capability that is tenuous, at best, under plain DOS. BlueMAX, Qualitas's memory manager for 80386-based PS/2's, is functionally similar to 386Max; however, it offers several features (such as BIOS code compression) designed specifically for the PS/2 architecture.

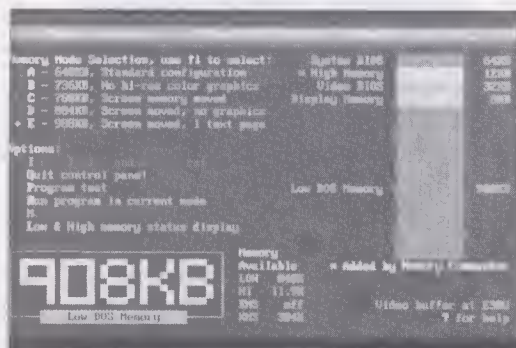
Price: \$99.95 each **Requirements:** 386Max: 80386 or higher PC (or an 80286 with supported chipset); DOS 3.0 or later; 256 Kb or more extended memory; hard disk BlueMax: 80386 or higher PS/2; DOS 3.0 or later; 256 Kb or more extended memory; hard disk **Company:** Qualitas, Inc.; 7101 Wisconsin Avenue, Suite 1386; Bethesda, MD 20814; (800) 676-6386; (301) 907-6700.

V Communications, Inc. Memory Commander

Memory Commander is a program that deserves wider recognition. It lets you create more lower RAM than any other program—up to 800K for graphic applications and 920K if you use text-base applications (such as dBase) on a VGA system. I achieved 770 free RAM just by running the (simple) installation program.

Memory Commander operates on a different philosophy than the other programs reviewed. It was unsettling, after installing the program, to discover none of the familiar "loadhi"-type statements in CONFIG.SYS—only a simple device-driver line. Memory Commander works by storing its settings in a user-configurable database—the appropriate configuration is automatically (and transparently) implemented when you start a program. It's easy to enter applications in this database, but some trial-and-error is required.

Although Memory Commander makes it simple to achieve a massive



amount of RAM, optimizing it requires a fair amount of memory-configuration know-how. The program's menus offer an intimidating assortment of choices. Some, such as the ability to manipulate the EMS page frame or rewrite the DOS memory map, are standard—if most appropriate for gurus—while others, such as the ability to set the root directory size on the program's included RAM disk, are unusual. The menus also include many well-written informational screens designed to help you optimize your setup. Memory Commander's organization is different

from that of the other programs in our lineup, and seemed strange at first. However, it's apparent that much thought and care has gone into the program, and I was impressed with the economy and logic of its menus. While the sheer number of the program's menu choices may be intimidating at first, many of these choices consist of simple yes/no toggle settings—a boon to experiment-

ers. The program's installation routine is excellent and polished and the manual does a good job of explaining even the most abstruse concepts. (A particularly useful section describes how to use Memory Commander on special hardware, including network cards, hard disk controllers, and video adaptors.)

Memory Commander provides extended and expanded memory support, although it lacks the many options and sophisticated tools provided by QEMM-386 and 386Max. There's also no systems-information utility. The program does offer a video ac-

celerator, RAM shadowing, and a RAM disk, and also supports on-the-fly memory configuration for TSR's, automatically remapping RAM as TSR's are loaded and unloaded. I had

no trouble using Memory Commander with Windows 3.1.

Memory Commander is a tinkerer's dream. It is probably more appropriate for experienced rather

than novice users, although anyone seeking to get the maximum amount of lower RAM, particularly for text-based applications, should certainly consider it.

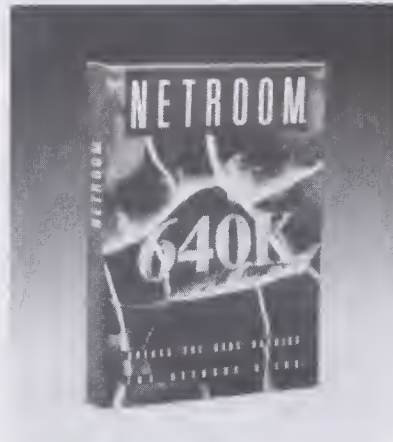
Price: \$99.95 **Requirements:** IBM PC or compatible with 80386 or higher microprocessors; 512K extended memory (1Mb extended memory recommended); DOS 3.0 or higher; hard disk **Company:** V Communications, Inc.; 4320 Stevens Creek Blvd., Suite 275; San Jose, CA 95129; (800) 648-8266; (408) 296-4224

Helix Software, Inc. NETROOM v. 2.0

There are no surprises with NETROOM—just the standard complement of extended and expanded memory management. The tools are basically of the same types as those provided by QEMM-386 and 386Max, only, of course, going under different names.

Installation is simple, and follows the same two-step procedure as the other programs. A "CUSTOMIZE" program automatically configures your boot-up files for optimal memory use: I was able to achieve 638K free lower RAM after using Customize, however the program ignored the RAM switch on my Stacker device driver line, and disabled my Stacker coprocessor card—the only program in the lineup to do so. Some manual fiddling was required to repair the situation. CUSTOMIZE is found as a menu option in the "DISCOVERY" command center program: DISCOVERY also includes systems information options similar to those found in Manifest or ASQ, although it is less polished than those programs.

NETROOM offers several unique features. As the name implies, the program was originally devised for



networked PC's, which usually have more than the usual number of TSR's (including network-card drivers) loaded. Perhaps because of its roots, NETROOM offers NETSWAP, a unique feature that lets users optimize memory use in the presence of many TSRs. NETSWAP sets up "virtual" DOS machines—in effect, letting you switch between two full sets of lower RAM, one for applications, and one for TSR's. (The second set is RAM borrowed from your extended or expanded memory.) This maximizes the amount of lower RAM

available for your applications, and is particularly useful when running memory-hogging networks, such as Novell or LAN Manager. NETROOM also offers the ability not just to shadow BIOS code into higher RAM, but to compress the unused portions of that shadowed code, thus freeing up more memory.

Finally, NETROOM is the only one of the programs reviewed to let you load not just the DOS files and buffers, but also COMMAND.COM itself, high.

NETROOM is probably one of the best choices for someone who will be upgrading his or her computer. It is unique among the memory managers reviewed in supporting all PC's, from 8088's on up. No special hardware is required for 80286's and 8088's, although expanded memory boards or a Chips and Technologies NEAT chipset will increase the benefits you'll accrue using NETROOM. Also, users who may one day network their PC's should consider NETROOM, since the program was designed with networks in mind. I had no trouble running Windows under NETROOM.

Price: \$99 (multi-user licenses available) **Requirements:** PC (8088 or higher microprocessor), some extended or expanded memory. **Company:** Helix Software, Co., Inc.; 47-09 30th Street, Long Island City, NY 11101; (800) 451-0551, (718) 392-3100

Building a 486 Power Station

If you're just not satisfied with what the mainstream manufacturers are offering in a 486 system, our experts tell you how to do-it-yourself.

Nicholas Lavroff, with Steven Helden and Catherine Keatley

Computer buyers today are faced with more options than ever before. They can choose from several chips within the same Intel family (such as the 80386 and the 80486), different configurations within each chip (SX or DX), and different levels of performance within each configuration (16, 20, 25, 33, 40 or 50 megaHertz). And that's just the CPU chip.

Similar options are available for virtually every other component of the computer, including the case (baby, mini and full tower, as well as the standard desktop case), the video display adapter (EGA, VGA, SVGA), the display itself (interlaced vs. non-interlaced, and a dot pitch that can vary from .25 mm to .50 mm or more), and the hard drives (IDE, SCSI, MFM, RLL). Faced with such choices, it's no wonder that many buyers are basing their buying

decisions on their budget rather than on their needs. After all, it's a lot easier to approach a computer dealer with a fixed sum of money, and ask for the best that that amount of money can buy. But while this might be easier on the decision-making process, it leaves the hapless buyer open to the kind of mercantile abuse that is traditionally associated with used cars and oriental rugs: ("How much is that one?" "How much do you have?"). This article serves a two-fold purpose.

If you are planning on building your own computer, and you want to build a top-of-the-line powerhouse, this article can help you choose from the forest of options, and show you how to put together a system that will work for you. Building your own computer can save you money, or at least guarantee that the money you spend goes toward the quality of

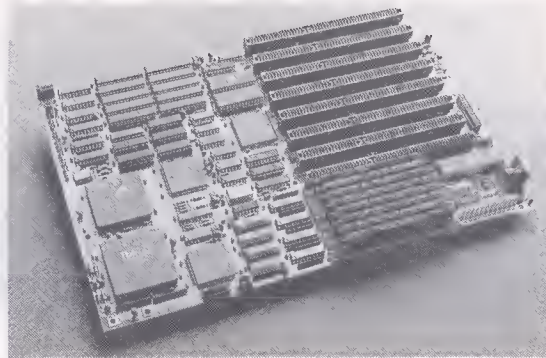
the components, rather than toward the quality of life of the computer dealer who sells you the system. But even if you are planning on having a dealer put a system together for you, this article can help you understand the differences between the available options, and put you in a better bargaining position.

We'll begin by describing the components that make up a powerhouse 486 system (including the myriad of choices), and follow up with some simple step-by-step instructions for putting one together.

Motherboard

The motherboard is the heart of the computer, containing the microprocessor, support circuitry and six to eight slots for expansion boards. Two manufacturers with excellent reputations for quality products are

The Pioneer Computer Vantage 486/25 and 33MHz motherboard can accommodate up to 32MB if you buy the more expensive 4X9 DRAM SIM modules.



Micronics and Mylex.
Considerations:

1. Microprocessor:

Because we will be building a 486 powerhouse, the motherboard must support an 80486DX microprocessor running at 33 to 40 MHz (megaHertz) or more.

2. Memory: You should be able to upgrade DRAM on the motherboard itself. SIM modules are easy to handle, they come in strips with edge connectors that are easily added to the motherboard.

This avoids installing the DRAM

Tip:

You want the manufacturer of the motherboard to have a published list of the different DRAM manufacturers whose chips have been tested and are approved. It is important that this list contain at least 3 different manufacturers.

on a card and using up an extra slot. The DRAM memory on the motherboard should be on one-by-nine SIM modules, each module containing 1Mb of DRAM. You should have enough room on the

motherboard to install 16Mb of DRAM.

3. BIOS (Basic Input/Output System): ROM-BIOS represents the basic table of interfaces between your PC's operating system and the outside world. DOS utilizes BIOS services to address the hardware. The newer versions of ROM BIOS have extended tables and can, therefore, accommodate newer hardware devices.

The general theme is for BIOS tables to lag behind hardware. This can be compensated for through the use of BIOS overlays, software device drivers that can leverage off existing BIOS functionality or simply replace the BIOS chips.

Most boards come with a ROM BIOS chip installed. Check before buying the motherboard to be sure it is included (they can be expensive). If you plan to install your own BIOS chip, make sure the motherboard can accommodate chips from different manufacturers. The most popular examples are AMI or Phoenix BIOS.

4. Bus Configuration: The bus is responsible for shunting data back and forth between the CPU and the cards plugged into the slots in the motherboard. Two competing standards are available: the ISA (which

provides a 16-bit data path), and the EISA (which provides a 32-bit data path). While the 32-bit data path would provide superior performance, the problem is that the choices of upgrade cards are so much greater in the 16-bit configuration. Therefore, if you opt for the EISA bus, make sure it can accommodate 16-bit cards as well as 32-bit cards.

Theoretically the EISA standard is a superset of ISA and should accommodate all ISA boards. Unfortunately, many manufacturers use the term EISA in a very loose fashion. Ask whoever you are buying it from to double check.

If the EISA configuration represents a greater than 15% markup over the ISA configuration, then select the ISA configuration, as the gains in performance would not support the

B.S. ↑ W.R.G.

Tip:

Buy a motherboard with the following built-ins to save time, money and add-on slots: hard disk drive controller (if you are using the IDE standard; see IDE vs. SCSI below); floppy disk drive circuitry; one or more serial ports and a parallel port.

additional expense.

X X

5. The battery: The battery associated with a motherboard is called a CMOS (Complimentary Metal Oxide Semi-conductor) battery. It maintains PC hardware configuration features while the PC's power is off. For example, the PC's clock chip is supported by the CMOS battery.

The new wrinkle from motherboard manufacturers is to solder a CMOS battery onto the motherboard. Unfortunately, the life span for these batteries is about three years. There-

X

VU/IMPE BATTERY
 ↓
 fore, it is important to be able, at some point in the future, to have the capability to disable the onboard battery and install an external one.

6.SRAM for Cache: Static RAM (SRAM) is a type of extremely fast RAM. It is used to form a RAM memory reservoir for the CPU chip so that instructions can flow into this memory as the CPU is busy. After the CPU completes its current task it, therefore, won't have to wait for new instructions to be sent to it. The microprocessor can simply retrieve instructions from the available pool stored in the SRAM.

The effect of this is to greatly enhance the operating efficiency of the CPU chip and, therefore, improve processing speed. These chips are generally located adjacent to the CPU and offer two basic configurations, 128K and 256K of memory.

You want the motherboard to utilize such a CPU cache system, and you want to be able to have options in how much SRAM (Static RAM) to install.

7. Miscellaneous Considerations: If the manufacturer offers motherboards in both a standard and baby form factor, always select the baby. In most cases, the standard board is

based on an older design, while the baby boards use specs that are usually more demanding. In addition, a baby motherboard is much easier to work with, and gives you more leeway when you select your case.

Price: A baby 486 33Mhz EISA motherboard, with 4Mb of DRAM and 64Kb SRAM onboard and which satisfies the above criteria, should cost about \$1400 plus or minus \$100. Because DRAM prices continue to spiral downward, it is a good idea to delay buying DRAM until you really need it. For that reason, plan on purchasing DRAM in 4Mb increments of one-by-nine SIM modules, until you reach your full configuration of 16Mb.

Note: Make sure either the distributor provides technical support or has access to technical support, also get at least a 90 day guarantee on it and a fully documented operations manual.

Power Supply

To run a feature-laden 486, you'll need lots of watts. Buy a 275-300 watt power supply. Some cases come with power supplies. See Case section below.

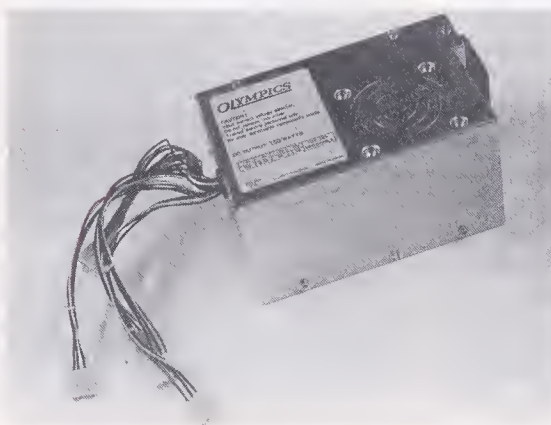
Case

In the old days, a PC case was a PC case, presenting the buyer with about as much choice as the color scheme on a Model T. Nowadays cases are available in a number of shapes, sizes and configurations. Which one you buy depends on your specific needs. First, you need to decide whether to use a standard desktop case (so-called because it sits horizontally on your desktop) or one of the more contemporary tower cases.

Tower cases are designed to sit upright (tower-like), either on the desk to the side of the monitor, or on the floor under the desk. (Of course, there is no reason why you can't set a desktop case upright, even though they are designed to sit horizontally. This is often the best compromise.) Second, you should decide which size to get. While desktop cases are generally only available in one size, tower cases come in three sizes—baby, mini, and full. If you need continual access to the motherboard and the other internal components, then the desktop case is your best choice. We have found that the bays on desktop units allow for easier access than the bays on a tower system. Of course, there are usually more bays available on a large tower system. Desktop cases have more interior

Tip:

If you're buying a power supply separately, make sure it will fit the case (this goes for all the other components as well). Also, make sure the case cutouts will fit your components. Don't waste your money on fancy cases requiring more assembly and circuits to connect, and avoid digital read-outs telling you the speed of your computer, as they cost more and don't measure anything useful.



Most power supplies have six cables coming from them: four are for disk drives and two are for the motherboard.

DRIVES ✓ 5 1/4" 3 1/2" 1.4MB + IDE 140 MB

space to work in, and provide easier access to the motherboard's bus area, while tower cases tend to be awkward to work with, especially if you will be installing a large number of interior components.

On the other hand, if you don't plan to upgrade your system continually, and you are willing to put up with a little inconvenience in the initial installation, then you might consider a tower case.

Choose the full tower case if you are planning to install a large number of components (such as multiple hard drives, a CD-ROM drive, a removable hard drive, and multiple floppies).

Remember, however, that although the smaller tower cases might accommodate your present needs, they don't provide as much room for expansion, and you may find yourself out of room before you're ready to buy a new system.

Whichever case you decide to buy, make sure it has three bays for floppies and room for two half height hard drives. It should also come with a 220 watt power supply (unless you're planning on installing a more powerful one yourself) as well as all the necessary installation hardware: special screws and rails for the floppy and hard drives, plastic footings, posts and screws for the motherboard and a power cord and all necessary cabling from the power supply, an external CMOS battery case and cable.

If you purchase your case from a reputable distributor, all these extras should be part of the package. You also should purchase your PC keyboard at the same time. You can generally get a package deal on a case and keyboard combination. You can expect to pay \$175 (plus or minus \$50) for a case and keyboard combo.

Floppy Disk Drives and Controller

If your motherboard isn't equipped with the proper circuitry, you will need to install a floppy disk controller card. You should plan on installing two floppy drives, a 5 1/4" and a 3 1/2" 1.4Mb. Make sure that the controller you buy can handle both. TEAC drives generally have the highest quality (they are quieter and more reliable than most other brands), although they tend to cost a little more (about \$75 apiece).

Hard Disk Drive

Today's powerful programs require maximum data capacity. For running Windows, the minimum recommendation is a 120 megabyte drive. The hard drive can be the single most expensive component you buy for your system, so shop carefully.

Here are a few general rules of thumb:

- Two smaller hard drives are better than one huge one. We recommend this simply on the basis of security. It pays to diversify.
- It's better to have two drives installed rather than one. The probability of both drives failing is significantly less than that of one. Your controller interface will support two hard drives as well as two floppy and a tape unit.
- Avoid MFM or RLL drives—these are based on an outmoded and inefficient technology.
- Purchase your disk drive controller card and drive cables with the hard disk as a package deal, thereby nipping any compatibility problems in the bud.
- Purchase half-height 3 1/2" drives. We recommend either IDE or SCSI drives. They have fast access times, they are dependable, and they are

easy to install and maintain. The Conner 200MB 3 1/2" IDE drives are highly recommended, as are similar drives from Maxtor and Seagate.

Two of these drives with the hard and floppy disk drive controller cables, AT expansion kits and cables, should cost \$1200 (plus or minus \$100).

The newer SCSI Small Computer Storage Interface) drives have enormous capacities, up to 1 gigabyte or more, with no compromise in reliability. The main advantage of a SCSI system is that it lets you daisy chain a large number of devices together, without the need for additional controllers.

SCSI drives don't really have a hard disk controller card but a hard disk interface card. This is because the controller is embedded on the drive itself. The card simply maps the CPU memory lines to the embedded controller. This arrangement results in a hard disk controller/hard disk relationship that is optimal. These drives are faster, have a larger capacity potential and are more dependable than the older architecture. Needless to say they are also more expensive.

If you plan on expanding your system by adding more hard disks or a CD-ROM drive, you might consider a SCSI system.

Display Adapter and Monitor (16 bit VGA board)

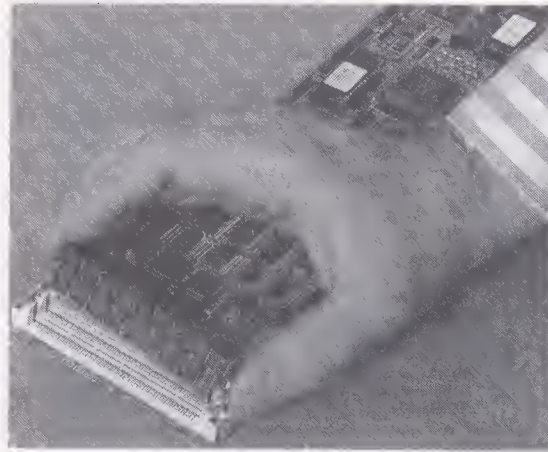
Your sole means of communicating with your computer is through the video display, so it makes no sense to sacrifice quality in this area. (Using a cheap monitor with a powerful computer makes as much sense as using tinny speakers with a top-of-the-line stereo system). The best approach is to purchase the highest

quality video card and price-competitive monitor. The video card should be a 16-bit data-path Super VGA card with a 70Hz plus refresh rate and 1Mb of VRAM onboard. A good example is the Orchid 1280 Fahrenheit Card. Use the Orchid as a standard, and make sure that the card you purchase has comparable specs.

Monitors vary in terms of dot-pitch (the minimum distance between adjacent dots), and whether their scan lines are interlaced or not. Generally speaking, the smaller the dot pitch, the crisper the resolution. Avoid monitors with a dot pitch greater than .35 mm. A good standard is .28, with .25 representing the top-of-the-line. When you purchase a Super VGA monitor, make sure it has at least a 90-day guarantee period. When you burn it in, check that the hardware video controls operate in accordance with the manufacturer's specs. If they don't, send it back for a replacement and keep doing it until you are totally satisfied. It is best not to purchase a monitor based on name recognition, as manufacturers often produce equivalent quality monitors under a variety of names. If you choose to buy a name monitor, you may pay a premium. The best approach is to contact a distributor, and find out what monitor is currently selling well. Make sure it suits your specs and purchase it with the understanding that you will return it if it is even slightly defective or unsatisfactory. You can expect to pay \$350 (plus or minus \$50) for a top quality video card and \$350 (plus or minus \$50) for a Super VGA monitor.

Keyboard

Just as the monitor is the computer's sole means of communicating with you, the keyboard represents your



The first step in assembling your power 486 system is to install the memory chips. Be sure to check for proper orientation and pin-to-socket alignment.

main line of communication with the computer. Ignoring quality considerations for the moment, you should choose a keyboard with an action that feels good to you. The best keyboards give you tactile feedback to let you know when the key has made contact. The most common keyboards today are usually referred to as the "101" keyboards, in reference to the number of keys. These range in price from about \$30 to over \$100 for the higher quality keyboards. For the most part, quality is reflected in price. A cheaper keyboard might work well for a while, but you have little assurance that it will keep working. Unlike the cheaper models, the higher quality keyboards use switches for the keys, providing greater assurance of longevity.

There are actually two different types of keyboard, mechanical and contact. Mechanical keyboards like those found on an IBM system, have a solid click and feel to them. All other keyboards are contact keyboards which use magnets and have a softer feel. Mechanical keyboards can be expensive, as much as \$250. If you shop around and try to get a deal on the system case sometimes the supplier will include the keyboard

in the deal. Use this inexpensive keyboard as a spare and purchase a mechanical keyboard for every day use.

Input/Output (Parallel and Serial Ports)

Buy a motherboard with serial and parallel ports installed. You'll need two serial ports (COM1 and COM2) and one parallel port (LPT1). Make sure the board includes a game port so you can connect a joy stick. If your motherboard does not come with serial and parallel ports installed, you can install a multifunction board. Multifunction boards can give you an entire array of functionality on one card, including drive controllers, memory, and a clock with battery backup. Depending on the configuration of your motherboard, you can use a multifunction board to provide you with the functionality you need.

Buying Parts

Prepare a comprehensive acquisition plan.

First, decide on the configuration you need, listing each component, potential vendors, and a price range

for each item.

Where to buy parts:

- **Specialty Stores** Prices are higher, but you can get help if you have a problem.
- **Mail Order** Use charge cards or the COD option. Ask the company for the latest price lists as prices can change without notice. Consider using a company that has been in business for a while—they are more likely to be around if you are having problems.
- **Swap Meets** Use merchants who have stores. You'll be able to get help if you have problems. Get a phone number for technical support, a money back guarantee and a receipt. (See PC Upgrade, Vol 1. No. 2 for more information on buying at a Swap Meet. See Swap Meet schedule elsewhere in this issue.)

Preparation

Before you start, clear a large area (at least 6 to 10 square feet) to work on, and gather all the tools you will be needing. (See Rebuilding an XT and AT for a detailed description of the kind of tools we recommend.) Set aside about two hours to complete the hardware assembly, since interruptions may cause you to lose momentum, or worse, forget to carry out a critical step.

You will need the following tools:

A large work table, with good lighting. If it's not in the budget to buy more tools we have even used a "Swiss army" knife to good advantage. In addition, small and medium Phillips and flat-head non-magnetic screw drivers (four total) and electrical tape; small needle nosed pliers

IC insertion tool.

Optional equipment: Flash light, static wrist band and static mat.

Software tools: Disk formatting tool (Ontrack 4.2 or later); A hard-

ware diagnostic tool (like QA-Plus by Diagsoft); A memory manager like Quarterdeck's QEMM-386 (See Test Center for complete results of our Memory Management software evaluations.)

General Assembly Instructions

1. Read all the documentation that comes with the separate parts you buy. Become familiar with each part, how it should be placed and oriented in the case, and any adjustments you may need to make to configure it to your system. Check to be sure the parts are compatible with each other before you begin building. If you have any questions about components, get the information before you start putting things together.

2. The major threat to guard against during assembly is static electricity. Static electricity can ruin the motherboard or any of the other components in the blink of an eye.

The following safeguards should eliminate the possibility of damage from static electricity. First, carry out the assembly on top of the static mat. Second, plug the power supply (with the switch in the off position) into a properly grounded outlet. Touching a grounded power supply can dissipate any accumulated static electricity in your body. Third, wear your static wrist band, attaching the other end to a ground. In addition, you should avoid carrying out the assembly on a carpeted floor, and you should wear rubber-soled (not leather) shoes.

3. Never force anything; if it doesn't fit easily, it's either not mated correctly, or the parts aren't meant to fit together. Always apply steady pressure when you insert cards into the bus.

The Assembly, Already

This is the fun part. After spending weeks deciding on your ideal configuration and tracking down the parts at the best prices, you are finally at the point where you can start putting components together.

Step 1. Insert the memory chips into the motherboard. Check orientation before proceeding so you don't install them backwards and damage them. Also make sure that all the pins of the chip are properly aligned with the socket before you apply any pressure. If the pins are flared out (as most are to accommodate automatic chip inserters), you will have to bend them in slightly before inserting the chips. You should do this on a flat surface, bending all the pins at one time. Be particularly wary of the danger of static electricity during this operation. If this is your first time installing chips, it's a good idea to use an IC insertion tool.

We recommend purchasing a motherboard that accommodates 1X9 SIM modules rather than individual DRAM chips. SIMs are simple to install and each module represents 1Mb of DRAM. A novice should be able to install 16Mb of DRAM in 15 minutes.

Step 2. If your motherboard does not have a ROM chip installed, install the ROM chip. Check your manual to be sure there are no jumpers to be reset. In most cases the jumpers are permanently set.

Step 3. Install the motherboard into the case, making sure you insert the plastic stanchions into the proper holes as identified in the motherboard manual. The plastic stanchions are supplied by the case maker as well as all the hardware, screws, rails, etc. The actual installation of the motherboard is as simple as screwing a light bulb into a socket.

Handle the board only by the

Tip:

Make sure you get the AT installation "kit" with the 3 1/2 floppy drive. The kit consists of a 5 1/4-inch metal frame into which you place the 3 1/2-inch disk drive before installing it in the 5 1/4-inch bay opening.

edges (do not touch any chips or traces), and temporarily place the unit aside. Position the case in front of you so that the openings of the disk drive compartment are facing you. Lift the case on its side and insert the mounting bolts through the bottom of the case. Secure the bolts on the inside of the case with the threaded stand-off (stanchions) supplied. The stand-offs are important. They prevent the motherboard from touching the metal case and shorting out. With a screwdriver tighten the bolts against the stand-offs. The motherboard should be screwed down in at least two places.

Lay the case back on the table and attach the mounting hardware to it. When installing mounting hardware, place an insulating (plastic or nylon) washer on each stand-off and bolt. This is important. Do not forget the insulating washer or the circuit board traces on the motherboard may contact the case through the bolt and stand-off.

If your case didn't come with insulating washers, by all means buy some. Small nylon washers (#6 or #8), available at most larger hardware stores should do the trick.

Carefully place the motherboard inside the case. Line up the holes in the board with threaded holes in the case. On a desktop unit, the expansion slots on the motherboard should point away from you and line up with the cutouts at the rear of the case.

Insert a screw in the hole and tighten with a screwdriver. Avoid over-tightening.

This is a good time to test the height of the motherboard. Insert a card in one of the slots. With the card firmly seated in the slot, its rear mounting bracket should line up with the corresponding cutout in the case. The top of the bracket of the card should easily rest on the rear of the case. If it does not, loosen the motherboard mounting nuts and gently reposition the board until the bracket matches the cutout.

If the bracket is too high or too low, the motherboard itself is too high or low, so you will have to adjust the height of the stand-offs. Remove the motherboard and adjust the stand-offs.

Step 4. Install the power supply into the case. Line up the AC sockets, the ventilation fan and the on/off switch. The power supply is usually held in place with four screws from the back of the case.

Most power supplies have six cables coming from them: four are for disk drives, and two are for the motherboard. The set of four disk drive power cables will have three or four wires, colored red, yellow, and one or two black leads.

Note: Your power supply may only have one or two drive power cables in which case you may need a Y-connector to add lines. Don't worry about that now.

The motherboard power cables are as follows (the colors may not match):

Cable #1 (P8)	Cable #2 (P9)
Green	Black
Red or Blank	Black
Blue	Yellow
White	Red
Black	Red
Black	Red

You can easily identify the cables because the colors of the leads. Cables #1 and #2 fit the power supply to the motherboard. The ground leads, the black leads, must be oriented so they are adjacent to each other in the center of the motherboard's Molex receptacle.

As a safety precaution, check the manual to be sure you are properly attaching the power supply to the motherboard. This is one connection you don't want to get wrong!

Finally, most cases come with the power supply installed. If you are at all uncertain this may be the best route to travel.

Plug in the power supply (making sure the switch is in the off position).

Step 5. Plug the power connectors

Tip:

The Ontrack format utility represents a vital tool. It is the format utility that Microsoft forget to add to DOS. Many drive manufacturers, such as Seagate, ship this utility with their drives. Maxtor ships a variant of it. This utility has a BIOS overlay (see above) capability in which it expands the BIOS table, resident in the PC, thus enabling you to recognize manufacturer defined non-standard drives. The Microsoft DOS format utility is not comparable.

onto the motherboard Molex receptacle. Take care that the power supply cables are oriented so that the black leads from the power supply are together in the center of the motherboard's molex receptacle.

Step 6. Install the disk drives. Start by assembling the AT expansion kits for the hard drives and the 3 1/2"

floppy, and then attach the rails to the drives. It's a good idea to conduct a test insertion of one of the drives before attaching all the rails, as this is often a trial and error process. Install the hard drive first, followed by the B floppy, and then the A floppy. The disk clamping mechanism should be on the top, as should the indicator lamp at the front of the drive. Note that some cases may require a right-angled screwdriver to secure the drives. Connect the power leads to each disk drive. They are keyed to attach only one way. Your power supply should have more than one cable to supply the drives. If it doesn't you'll need a Y power tap to supply both drives.

IDE and SCSI hard drives will only have one cable going from the drives to the controller card. They also have a power plug receptacle. There is a red stripe on the cable that provides pin-one orientation on the card. The end that terminates on the drive can only be plugged in one way. Although the floppies technically do have send and receive cables, with the modern floppy drives these two cables are now joined into one cable. These cables can be plugged in only one way.

The installer should carefully read the motherboard manual at this point and make sure that all dip switch settings comply with the hardware he has installed. Typical settings relate to the type of video standard, amount of DRAM and SRAM.

Step 7. Install the controller cards if they are not built into the motherboard. Attach the signal cable from the controller card to the drives. The single end connector goes to the controller card and the two other connectors go to the drives. Drive A receives the connector at the very end of the cable and the other attaches to the B drive. If this order is reversed, the drives will not work,

but no damage will occur.

If you are installing two hard drives, make sure you carefully read the information that accompanies the drives. You will have to remove the terminating resistor on the first drive. The hard drives will be daisy chained with only the last drive, the second drive, terminated.

The exact mounting procedure for the drives varies, but most use a solid bracket to secure the left side of the drives, and a removable bracket for the right side.

With the hardware supplied with the case or drive, attach the drive units to the removable bracket. Do not over tighten the screws. Place the drives in the compartment, and set the bracket into its mating slots in the chassis. Finish the job by securing the left side of the drives to the left bracket. Use the hardware provided.

A number of computer cases use rails for attaching disk drives. These make installation much easier, as you need only attach the rail to the sides of the drives, then slide it into position. As the design of the drive rails can vary, you will need to consult the manual that came with your case.

Step 8. Install the display adapter board. Install any extras like internal modems, I/O boards, hard disk drive cards and controllers.

Remove your adapter card from its shipping box and inspect it. Secure the board to the computer by installing and tightening the screw in the bracket.

Install the display board in any of the expansion slots.

Step 9. Install the keyboard by attaching its cable to the connector located on the back of the case. The connector goes in one way only.

Step 10. After a final check to be sure everything is attached as it should be, start the computer. It will go through a RAM count and "flip"

into a CMOS configuration screen. At this point, you can set up the data, the types of peripherals you have (i.e., floppy types video standard) and the hard disk types (**Note:** the identifier type will be defined in the documentation that accompanies the drive). Once you finish with the CMOS editor, the computer will reboot. Place a DOS boot floppy in drive A with a utility like the Ontrack format utility.

Then conduct a high level format and partition your hard drives. The DOS system file will be transferred to the boot drive during this process. When this process is complete, you will be able to boot off your hard drive. Once DOS and your memory manager are installed your computer is complete. However, we recommend installing DiagSoft's QA-Plus and conducting an extensive test of every component. Set these tests up so they can run unattended in an overnight batch mode, writing all test results to a log file which you can examine later.

The Bottom Line

Twin hard disk equipped, 400Mb total; a 486 33MHz with 4Mb DRAM; Super VGA monitor and top of the line video card; 5 1/4" 1.2Mb and 3 1/2" 1.4Mb floppies; 1 serial and 1 parallel port = \$3,675. The advantage of building your own is that it is composed of the best available components. ■

Products Featured

Ontrack Data Recovery Disk Manager:

\$124.95 (single user);

\$319 (Novell)

6321 Bury Drive

Eden Prairie, MN 55346

1-800-752-1333

612 937-5167

Breathe New Life Into Your Old 286

Don't know what to do with those old ATs in your closet? Performing a CPU transplant can let them run all of the newest software.

In its day, the 286-based AT and its compatibles were tremendously popular. There are still loads of them around, plodding away. But compared to the newest 32-bit 386s and 486s, these AT-compatibles have some significant limitations. They're considerably slower, for one, and they can't run today's new Windows-based software in 386 Enhanced mode, which makes the best use of memory. Even if you're not running Windows, you can benefit from some of the advanced memory handling and conservation features of MS-DOS 5.0 with a 386 that just can't be taken advantage of with the older 286 CPU.

If you find yourself grinding your teeth every time a TV commercial for Windows 3.1 comes on, don't despair. There are a few alternatives to giving up life in the fast lane. Of course, you can just live with yesterday's technology or you can purchase more powerful systems. If neither of these alternatives feels especially attractive you can try a third alternative, a CPU transplant, upgrading your AT-compatible's 286 to a more powerful 386SX processor. This last alternative

just might be the answer to your dilemma. It's not particularly hard to do, in fact it's almost as easy as just plugging in a new chip.

The 386 SX is a better chip

When the AT first came out, a number of CPU upgrade kits which allowed you to put a 286 CPU into an original PC soon followed. None of these cards, like Microsoft's Mach 10, were particularly successful. They were both hard to install, and the performance gains they offered were minimal.

Upgrading from a 286 to a 386SX is a different story. The 286 is a 16-bit chip that interfaces to the outside world through a 16-bit peripheral bus. While the 386SX is a 32-bit chip, it also interfaces to the outside world through the same 16-bit ISA (Industry Standard Architecture) bus as the 286. The pinouts of the 386SX are a bit different, and its ability to more efficiently make use of large amounts of RAM memory also necessitate some additional memory handling chips, but these differences are easily accommo-

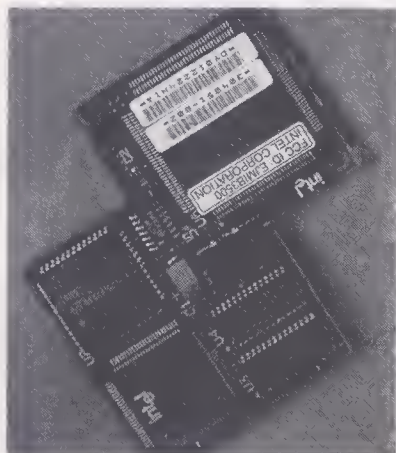
dated with a little circuitry. These small circuit modules contain the 386SX CPU, plus all of the additional support chips and circuitry needed to just let you plug the module into an AT-compatible's 286 motherboard socket.

But what kind of socket is this?

Sometimes upgrading the 286 CPU is as simple as just plugging in the new module, and sometimes it's not. Just to make things more interesting, there are three different CPU chip designs, and none of the three are plug-in compatible with the others.

The original IBM AT systems use a CPU chip design called PGA (Pin Grid Array). A PGA chip has two rows of pins running all of the way around the perimeter of the chip. Many AT compatibles also use the PGA chip.

The second most popular chip design used in 286 systems is the PLCC (Plastic Leaded Chip Carrier). PLCCs are plastic chips with metal contacts running around the outside of the chip (rather than pins on the bottom). While the PGA style chip plugs into a socket



The Intel SnapIn simply replaces a 286 microprocessor with a 386SX running at 30MHz for \$499.

on the motherboard, the PLCC sits down inside of the socket. PLCC chips are used in IBM's 286-based PS/2 systems, the Compaq DeskPro 286, and several others.

Finally, some compatibles use an LCC (Leadless Chip Carrier). These are generally ceramic chips with gold contacts on the bottom, rather than pins.

Depending on the particular type of CPU the machine you wish to upgrade uses, you may need to purchase an adapter kit, a different version of the module, or may not be able to use a particular vendor's product at all.

Do try this trick at home

Unlike many more complex upgrades, performing the CPU transplant isn't particularly difficult. Assuming that you have the right module and/or adaptor for your particular system, you won't have to do much more than remove the old 286 chip and insert the upgrade module. Plan on about 30 minutes for the job, which includes removing and replacing the cover, and installing any software drivers that might be necessary.

Before you run out to order your upgrade, take a look inside the machine you'll be upgrading. With some AT's and compatibles, the 286 socket on the motherboard is not easy to get to. With some systems, you may have to loosen the hard disk and slide it partially out of the system to reach the CPU socket. Many PCs will require you to install a socket extender so that the upgrade modules clear a motherboard mounting standoff located right next to the CPU socket. When you open the case, see how easily you can get to the CPU, what type of chip/socket is being used, and whether any peripheral cards will have to be relocated once the upgrade module has been installed.

Upgrading the CPU may not be enough

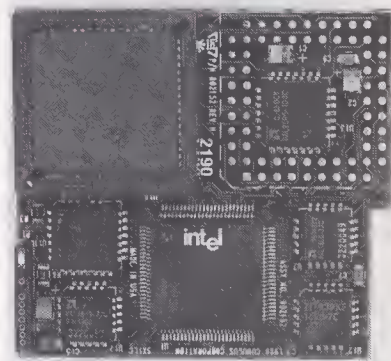
Actually, adding an improved CPU to an older machine is just part of the story. You'll still have to decide whether the other components, which will remain in the system, make the improved CPU worth the cost and effort. These components include the video card and monitor, and the hard and floppy disks. It's very possible that you've already upgraded the AT-compatible in these areas over the years. If not, you'll need to decide if you really want a 386SX system with an MDA (Monochrome Display Adapter) text-based display, and a 20Mb hard disk that's three times slower than that which comes with even the least expensive new 386SX!

The second significant limitation you'll discover in upgrading an original IBM-brand AT and many compatibles is the motherboard limitation of just 540K of RAM. There are very few programs these days that will run in this small a memory space, especially when you add in the overhead of MS-DOS's. Windows has an even larger memory requirement, with at

least a megabyte of RAM needed to even run.

If your AT or compatible is somewhat short on RAM, you'll need to add a 16-bit memory upgrade board. We installed an STB (STB Systems, Inc. 1651 N. Glenville, Ste. 210, Richardson, TX 75081, (214) 234-8750) PowerMEG board, and found it an easy to install solution to the RAM cram problem. STB sells the board with 0K RAM, as memory prices fluctuate daily, and it retails for \$239, though you can often find it for considerably less. 2Mb of SIMM memory cost us \$91 (including next day shipping), and we installed the board so that the first 128K of the PowerMEG's RAM backfilled the AT's memory to 640K. After this is done, you'll need to reset the PC's CMOS setup ROM to reflect the new memory installed. You're now ready to perform your CPU transplant.

Keep in mind that if you already have Windows up and running before upgrading, you'll have to reinstall Windows after changing the CPU. The Windows installation routine (in both



Cumulus 386SX Card

3.0 and 3.1) looks to see what type of processor it's running on. If it sees a 286, it doesn't bother to install the code needed to run in 386 Enhanced Mode. Be sure to check all of your other frequently used software packages to see if they, like Windows, also

need to be reinstalled.

Reasonable expectations?

With all six of the upgrade modules we reviewed, the actual swap was easy. You just pop out the old CPU using the special tool provided with the kit, and orienting the module for Pin 1 on the motherboard's CPU socket, plug in the module. You may have to move a few jumpers on the module, or install driver software, but in no case did it take us more than 30 minutes to install an upgrade.

Is it worth the time and money? It depends. If you're expecting blazing performance from just swapping a CPU, you may be in for a big disappointment. After all, you're still working with the older, slower RAM memory and disk drives. Most CPU upgrades will substantially improve those applications like word processing and spreadsheets. But with applications like database management, which are primarily disk intensive, you won't see much of a boost in performance.

What you do get with any of these CPU upgrades are several of the same benefits that buying a brand new 386SX offers such as the ability to run Windows and other 386-oriented software packages in 386 Enhanced mode (which lets you multitask and take advantage of additional system memory). You can also take advantage of MS-DOS 5.0's ability to make use of UMBs (Upper Memory Blocks), using the 386SX's improved memory management capabilities. And you can get these benefits for pretty much under \$400 (street price).

Does it make sense to upgrade your old 286 to a 386SX, or are you better off just spending \$1,000 or so on a new 386SX PC? It really depends on what you use your system for, and how much you've already upgraded it

over the years. If you have very disk intensive applications, or have to start adding new video, more memory, and other improvements, a whole new system might be a better answer. But if you just need to squeeze a bit of additional performance out of your 286, or need the 386 capabilities they offer, a CPU upgrade might be just the ticket.

And the winner is...

Assuming that you do decide a CPU upgrade is the answer, we recommend that you spend a little extra money and get one of the modules that both gives you 386 software compatibility and an improvement in your system's performance. Of the six, the Aox, Intel, and SOTA all offered a boost in addition to the compatibility.

But though it was the most expensive of the six with a \$550 retail price, the SOTA easily provided the most boost of the six modules. When the prices get translated down into street prices, the price differential between the Express/386, and its nearest competitor, the Intel SnapIn, should be minimal. If you're looking for a boost on a budget, consider the Aox Stax 25. With a retail price of under \$300 (and a street price probably a lot closer to \$200), it was the least expensive boost on a budget.

But if you can squeeze a bit more cash out of your budget, the SOTA Express/386 is our Best Buy for 386SX upgrade modules.

Reviews

CPU Upgrade Modules

ALL SX 386

ALL Computers is best known for their

memory management products including the ALL CHARGE Card which brings advanced memory management to 286-based PCs. The ALL SX 386 is their 386SX CPU upgrade module. A small rectangular circuit card, it is available in both PCLL or PGA configurations. In addition to the 386 board, ALL's upgrade kit includes their ALL CHARGE 386 Memory Manager. The retail price on the ALL SX 386 is \$299.

The ALL card is somewhat unique among the six upgrade modules that we tested in that it operates at the clock speed of the system it's installed in. ALL Computers recommends this module for machines that are operating at 12MHz or above and with zero wait state memory. In addition, the ALL card does not offer any type of caching, either between the processor and RAM, or of any of the system's BIOS (i.e.-shadowing.)

All claims this as a positive feature, noting that a cache miss in a system using one of the other upgrade modules can lower the system's performance to half of the un-upgraded level.

Maybe so, but you couldn't prove it by our test results. If you compare the ALL SX 386's scores on our Real World Benchmarks with those that SOTA's Express/386 managed, the cached 25MHz SOTA card blew the ALL SX away in most of the tests.

We probably would have gotten somewhat better results had we installed the excellent ALL CHARGE 386 memory management software that accompanies the package. As the manual (such as it is, actually just several photocopied pages) states, installation of this software is optional. And as we did not test any of the optional software with the other upgrades, it would be unfair to have included ALL's.

ALL Computers seems to be a bit ambivalent about how they're posi-

REAL WORLD BENCHMARK TEST RESULTS: CPU Upgrade Modules

Test	SCORES						
	Unmodified 8MHz Standard IBM-AT	ALL SX 386	Aox STAX 25	Cumulus 386SX Card	Evergreen Superchip II	Intel SnapIn 386	SOTA Express/386
dBASE:							
1)	361	404	188	437	369	172	140
2)	23	24	15	27	23	13	11
3)	26	15	11	17	14	9	8
4)	188	209	121	17	193	106	89
5)	79	88	49	97	81	45	36
6)	107	63	45	66	54	39	36
Word Perfect:							
1)	26	27	19	31	25	18	16
2)	180	123	61	128	110	73	51
3)	46	47	28	54	44	29	24
1-2-3:							
1)	did not	did not	did not	17	did not	8	7
2)	run	run	run	14	run	6	5

*All Scores are in seconds.
Lower scores equal better performance.*

For explanation of Real-World Benchmark tests, see page 51.

tioning this product. On one hand, their literature extols the speedup of extended memory functions by up to six times. Their manual, however, is much more direct about the true amount of performance improvement you can expect. For adding 386 style memory management to 286 class machines, the ALL SX 386 card is an excellent and inexpensive way to go. But as far as turning your older 286 PCs into a 386SX performance equivalent, it just doesn't compete with the more expensive Aox, Intel, or SOTA boards.

Aox Stax 25

The Aox Stax 25 is a small circuit board about 2 inches square, one of the smallest of the upgrades reviewed. It's available in both PGA and PLCC versions, and each version has the appropriate chip puller.

To install the Stax, remove the 286 CPU with the chip puller and align the module with Pin 1 on the CPU socket. Then insert the module into the socket, pushing down so that it's well seated. On our test AT, a standoff located directly next to the CPU socket pre-

vented the Aox module from seating correctly in the socket. An socket extender, which adds about a quarter-inch to the module unit and is packed in with the upgrade kit, quickly solved the problem.

We didn't need to install a software driver for the Stax 25 upgrade. The unit does, however, have a number of jumpers on the module that might need to be reset. These jumpers control the on-board caching, PS/2 compatibility, and whether the video BIOS is shadowed to system RAM before or after

the PC completes its power on tests.

Aox's documentation is very nicely written and organized, but could be just a more complete in the area of troubleshooting. Considering how easy the actual installation of the Stax 25 really is, this is the one place in the manual that should be the most complete.

Performance wise, the Stax 25 came in third, behind the SOTA and Intel modules, but in most cases, not by that much. The 1-2-3 benchmark did not run with the upgrade installed. Since this particular section of our benchmarks is preconfigured, and often does not run with anything other than a plain vanilla VGA setup, we did not penalize the Aox. In fact, the unmodified IBM AT also did not run this area of the benchmarks, nor did the Evergreen or ALL upgrades.

On the plus side, only Aox includes a ROM BIOS upgrade in their kit. A number of vendors mentioned that certain systems may need a ROM BIOS upgrade to operate reliably, but none other than Aox actually includes this upgrade. The Aox BIOS upgrade is a Phoenix 386 BIOS optimized for the Aox Stax, and gives you the ease of a ROM based setup routine, as well as support for 3.5 inch floppies and an extended hard disk drive table. Nice move, Aox!

The Stax 25 isn't as fast as the SOTA or Intel upgrades. It also isn't as expensive as either of the better performing duo. The Stax 25 gives you both 386 software capability and a modest performance boost. It's also the only upgrade module that will let you continue to use an existing 80287 numeric coprocessor if you already have one in your 286.

The Aox Stax may not be the speediest way to turn your AT into a 386, but at a street price in the \$300 range, it's certainly offers one of the more competitive price/performance ratios in the market place.

Evergreen 386 Superchip II

Evergreen's 386 Superchip II is a small rectangular circuit board that is inserted into the 80286 socket on the PC's motherboard. It is one of the few upgrade modules we looked at that's available in PGA, PLCC, or LCC type configurations. Our review unit was for PGA type sockets and needed an extension for the module to clear a small plastic standoff directly next to the 286 socket.

The Superchip II, you don't need to install driver software, but there is a bank of DIP switches. You will have to set these to match the system you are installing the board in. These settings allow the Superchip to double the system clock speed when possible, and to indicate what type of system you have. Switches three through seven match the Superchip with the 286's clock speed, and include settings from 6MHz up to 16MHz.

The last switch indicates whether there's an Evergreen Math Accelerator board installed. The Superchip does not let the PC utilize an existing 80287 coprocessor. Instead, a separate board must be purchased and installed to regain this function.

The Superchip's documentation is a 37 page photocopied manual. Most of this manual is just slightly different installation procedures for the different chip styles. The actual instructions for installing and setting the switches for any one model are only a few pages long. The manual's troubleshooting section is less than half a page long.

The Evergreen upgrade delivers on its promise of 386 software compatibility. You can run Windows in 386 Enhanced mode, after you've reinstalled it to recognize the 386SX CPU.

Evergreen claims only 386 software compatibility for the Superchip II, they don't promote it as a performance accelerator. Our Real World benchmark tests bear out their honesty, many of the tests we worse with the Superchip

installed than those achieved by the unmodified IBM AT!

The Superchip II, at \$199, is the least expensive upgrade module we reviewed. And it does deliver the 386 compatibility that it promises.

But by spending just a little bit more money on another vendor's product (such as the Aox Stax), you can have your cake and eat it too. That makes the Superchip's \$199 price tag somewhat less of a bargain.

Cumulus 386SX Card

The Cumulus 386SX card, as with the other upgrades, comes in multiple configurations. It is not available, however, with the relatively rare LCC type of plug. Cumulus supplies the upgrade in PGA configuration (used by true IBM ATs), and PLCC styles (for most PS/2s and Compaq DeskPro 286.)

As with the other upgrade modules we reviewed, the Cumulus card is a small circuit board that replaces the 286 CPU chip in the motherboard socket. It was the only upgrade to include Windows 3.0 as part of the package.

The Windows documentation is Microsoft's generic manual. The manual for the Cumulus card is much smaller, but is very well written and organized.

Installing the module consists of determining if the single wire jumper on the board needs to be moved, then installing the software driver. Most of the manual explains the installation and configuration of the software that accompanies the upgrade. We just specified an automatic installation, and the proper driver configuration was automatically installed in our CONFIG.SYS file.

Cumulus doesn't claim anything beyond 386 software compatibility for its 386 Card. A quick look at the

benchmark results shows they've been honest on this point.

If all you want is 386 software compatibility, you'll certainly get that with the Cumulus 386SX Card. The Cumulus 386 Card costs \$100 more than the Evergreen, but the vendor includes Windows 3.0. The big problem is that on most older 286 PCs, Windows might run in 386 Enhanced mode with the Cumulus card, but it won't run much, if at all, faster.

Intel Snapin 386

The SnapIn 386 is Intel's second generation of CPU upgrades. The first, Intel's InBoard/386 enjoyed only moderate success, but was, when it was introduced several years ago, an ambitious product.

While the SnapIn 386 is a much less ambitious product, simply replacing the 286 with a 386SX running at 20MHz, at a \$499 retail price it's bound to be a lot more successful. Somewhat larger than the other upgrade modules we reviewed, the SnapIn 386 is available in just two styles, a PGA configuration for original AT type systems, and PLCC model for PS/2s and Compaqs. The SnapIn is shaped somewhat like a pair of diamonds joined at one point, and required a socket extender to clear the plastic motherboard standoff.

Installation didn't pose any problems, and the SnapIn's large manual is excellent, pointing out all of the options and settings that might have to be changed. The SnapIn requires a software driver be installed in your CONFIG.SYS file, and the installation process is automatic.

Intel's SnapIn 386 accomplishes exactly what we'd expect of a 286 upgrade. It gives you 386 software compatibility and a substantial performance boost. It's easy to install, has an excellent manual, and Intel's ter-

rific support BBS.

The SnapIn took second place (behind the SOTA Express/386) in most of our Real World benchmark tests, but still turned in very good times. It's also about \$50 less expensive than the SOTA board at retail prices. We gave the SOTA board this month's Best Buy based on its overall performance. But we also consider the second place Intel SnapIn an excellent value.

SOTA Express/386

SOTA's been in the upgrade business for years, and if our experience with their product is any indication, they pretty well know what they're doing. The Express/386 aced out the competition, bringing our antiquated AT almost up to the performance level of a new 386SX system.

Installing the Express/386 was just a bit more difficult than the other

Products Featured

Price, company, and system requirement information relating to products mentioned in this article

ALL SX 386

Price: \$299 (includes ALL CHARGE memory management software)
Requires: 286-based PC with PLCC or PGA socket. Vendor recommends use in 12MHz or faster systems.
Company: ALL Computers, Inc.
1220 Yonge Street Toronto,
Ontario Canada M4T 1W1
(416) 960-0111

Stax 25

Price: \$495
Requires: 286-based PC with either PGA or PLCC socket.
Company: Aox, Incorporated
486 Totten Pond Road
Waltham, MA 02154
(617) 890-4402

Superchip II

Price: \$199.
Requires: 286-based PC.
Company: Evergreen Technologies, Inc. 915 N.W. 8th Street
Corvallis, OR 97330
(503) 757-0934

Cumulus 386SX Card

Price: \$299 (includes Microsoft Windows 3.0)
Requires: Any 286-based PC with PGA or PLCC type CPU socket.
Company: Cumulus Corporation
23500 Mercantile Road
Cleveland, OH 44122
(216) 464-2211

SnapIn 386

Price: \$499.
Requires: Any 286-based PC with PGA or PLCC type CPU socket.
Company: Intel, Inc.
PC Enhancements
CO3-07
5200 NE Elam Young Hwy
Hillsboro, OR

Express/386

Price: \$550.
Company: SOTA Technology, Inc.
559 Weddell Drive
Sunnyvale, CA 94089
(408) 745-1111

upgrades. It's just a slight bit larger, and wouldn't clear the drive bay frame on our IBM AT test system.

The answer to this problem is quickly found in SOTA's excellent documentation. The Express/386 card has a PGA plug, but SOTA can provide adapters for both PLCC and LCC type sockets. The solution to the fit problem was to use the LCC adapter set, which has a flexible cable. This allows the board to be located several inches away from the socket and velcroed to the computer frame, hard or floppy drive cables, or the like. Using the flexible cable adapter adds only about an extra five minutes to the upgrade process.

The Express/386 has a socket for a 387SX math coprocessor, and installation of this as simple as plugging the 387SX into the available socket. As with all of the upgrades other than the Aox Stax, the SOTA module cannot be used with an existing 286.

The Express/386 doesn't have a lot of jumpers. In fact, the only jumper

that may need to be set is one that indicates to the module whether you are installing it in an MCA bus PS/2 system. The default setting is for non-MCA systems, so chances are, you won't need to touch the jumper.

You will, however, need to install a software driver which not only enables the 386SX CPU on the card, but provides a variety of other functions and utilities such as caching.

The Express/386 normally provides a RAM cache and also moves the system's ROM BIOS and video BIOS routines into RAM, where they can be accessed much faster. If you experience any problems with the caching, you can turn this feature off.

SOTA also provides a RAM cache utility for the hard and floppy disks. This feature can speed up disk intensive operations considerably. There's even a utility to provide a RAM disk, which, with enough RAM memory, lets you emulate a disk drive in the faster RAM memory of your PC.

SOTA, like several of the other ven-

dors, provides an electronic BBS that you can dial into to obtain the latest software updates. This is a nice thing to have, as downloading software updates through a modem link is much faster than waiting for a disk in the mail.

Performance and more

Of the 6 upgrade modules we tested, the Express/386 was the clear winner in our benchmark tests. At the same time, it's also the most expensive. With a retail price of \$550, it's close to costing about the same as a 386SX motherboard.

The saving grace with the SOTA board is that it's a whole lot easier to install than a replacement motherboard, and it gives much of the same performance gain.

Performing a CPU upgrade on a 286 isn't for everyone, but if it is the way you've decided to go, the SOTA Express/386 gets our nod as the Best Buy. ■

PC UPGRADE's Real-World Benchmarks Explained

dBASE IV

Test 1	Index a 10,000-record database 3 times on 3 different fields—1 text, 1 numeric, and 1 date.	Measures disk and memory performance.
Test 2	Append blanks 300 times to 300 records.	Tests memory performance.
Test 3	Locate 55 records in a 1,300-record database.	Measures hard disk performance.
Test 4	Perform 16,000 Stores.	Tests total system performance.
Test 5	Perform 3,700 Gets.	Tests memory and CPU
Test 6	Open and close a database file 300 times.	Measures hard disk performance.

WordPerfect 5.1

Test 1	Search 19,000-word document for "and" and Replace with "AND," then reset and Replace "AND" with "and."	Tests memory and CPU performance.
Test 2	Spell Check 19,000-word document.	Tests general system performance.
Test 3	Change type size of entire 19,000-word document from 12 points to 9 points, repaginate, then reverse process and repaginate.	Tests general system performance.

Lotus 1-2-3

Test 1	Recalculate large financial report based on changes in first-year figures.	Very memory intensive.
Test 2	Perform multiplication on matrix. Uses matrix in which each cell is random multiple of preceding cell.	Memory intensive.

Five Easy Steps to Hard Disk Revitalization

While the editors of PC Upgrade cannot offer you a shot of the elixir of life to revitalize your war-weary hard drive, there are quite a few remedial steps that can be taken to put some zip back into your old hard disk.

Hard disks are a lot like people in one respect—they tend to slow down as they get older. But before you consign your older hard disk to the trash pile, there are a number of things you can try to breath new life into it. These computerized “vitamins” won’t give you the same performance that a newer, faster hard disk and controller will, but they’re a lot more economical, and may let you get another few years out of your tired old drive before it has to be replaced.

Most of these boosters take advantage of the way that a hard disk is organized, accessed, or the manner in which DOS handles the hard drive.

Step 1: Defragmentation

One of the easiest disk speed-up tech-

niques is to defragment your disk. One major reason disks appear to slow down is because of the way that MS-DOS handles files. When DOS needs to write a file to disk, it examines a special table on the disk called the FAT (File Allocation Table). This table tells DOS which sectors are not currently being used by files. DOS selects the first open file area that is large enough to hold the file it needs to write, and places the file in this area. When you change this file, either by deleting part of it, or adding to it, DOS does not look for another area large enough to hold the now somewhat different sized file. If you’ve deleted from the file, making it smaller, DOS just notes in the FAT that part of the previously occupied area is now free, and can be used to store additional data. If you’ve added to the original file,

though, DOS looks at the FAT for an area large enough to hold only the additions that you’ve made, writes the additional data there, and places a pointer at the end of the original file which tells where the file continues. The additional part of the file does not have to be physically located anywhere near the original file, and in fact, is probably not. This happens every time that you change the file. After a few changes to the original file, it’s a good bet that pieces of this file are located all over the disk’s surface, with pointers at the end of each piece giving directions to the next piece of file. With large word processing files, desktop publishing files, or graphics files that are frequently updated and changed, this file fragmentation results in longer and longer load and access times.

If you’ve used your hard disk for

more than a few months, chances are good that your files have become fragmented even if you haven't noticed a definite slowing down of disk-based operations. The solution is a simple one. Software utilities, called defragmenters, reorganize your files on the disk, consolidating all of the pieces into one large contiguous file. Programs like OPTUNE, from Gazelle Systems, and the defragmenter included as part of the Norton and Central Point utilities, should be used at least once a week to keep your files from being distributed in small pieces all over the surface of your disk. The biggest problem with file fragmentation is that you really don't notice just how much your disk has slowed down until the first time you use it after it has been defragmented.

Step 2: Changing Disk Interleave

With somewhat older hard disks, changing the disk interleave can also boost performance to a noticeable extent. The disk interleave is the number of sectors that sequential logical sectors are offset from the physical sector layout. Because a hard disk is spinning at about 3600 RPM, by the time the disk head reaches the end of a sector, and the data transferred first to the disk controller and then to the PC, the next physical sector following the one that has just been read from or written to has already passed partially or completely under the disk's read/write head. Actually, depending on the exact speed of the disk, the speed of the PC, and the data transfer rate of the disk controller, several sectors may pass underneath the drive head before the PC is ready to read or write the next logical sector.

To get around this problem, drive and controller manufacturers came up

with the idea of offsetting sequential sectors. The offset, called the disk interleave, is the number of actual physical sectors between sequentially numbered logical sectors. In many older disk/controller combinations, this interleave is 3:1, or even 4:1, that is, there are three (or four) sectors between one logical sector and the next sequential sector that needs to be accessed. This gives the drive heads enough time to get in position for the next sequential read or write. With newer, faster drive and controller combinations, the interleave is frequently 1:1, that is the sequential logical sectors are also physically adjacent.

Until the very high performance drive and controller combinations became available, vendors tended to be very conservative in setting drive interleave. Disk and controller performance could vary greatly, even within the same production run, so by setting the interleave high enough, they could be assured that even a marginal drive or controller would work. The drive/controller combination might work at a 2:1 interleave, but it definitely would work at 4:1. Smaller interleaves, like 2:1, yield better performance, but with the older drives, needed to be determined on a case by case basis.

Fortunately, interleave is easily tested, and just as easily reset. Many of the disk defragmenters mentioned above will test your drive's interleave, and allow you to reset it if a smaller interleave will work reliably. However, there is a utility for disk tuning that we prefer to use for this purpose—Gibson Research's SpinRite II. SpinRite will not only determine the most effective disk interleave for your particular drive/controller combination, and reset the interleave if you wish, but it can also perform diagnostics and low-level

format the drive at the same time.

Step 3: Reformatting

Another reason that disk performance can suffer in older drives is that areas on the drive can lose the ability to hold a magnetic charge. If there's data in that particular area when this happens, you get an error message when you try and access the file. MS-DOS is supposed to monitor the drive, and lock out these areas as they occur, but it doesn't do a very good job at this particular task. When you format a hard drive using the DOS FORMAT command, these areas are recognized and barred from use. So one way you can protect yourself, and improve performance, is to regularly back up the drive and reformat it. Performing a low-level format, which actually rewrites every bit on the surface of the disk is the best way to lock out bad tracks, but should not be attempted unless you really understand what is taking place. The UNFORMAT utilities contained in the Norton and Central Point utilities, and in MS-DOS 5.0, will let you recover from the MS-DOS FORMAT command, but once you've performed a low-level format, your disk has been wiped clean, with no chance whatsoever of recovering anything from it.

And with the newer IDE (Integrated Drive Electronics) hard disks, the low-level format has been applied by the factory. Some of these drives can be low-level formatted by a user, but attempting to low-level format most IDE drives just results in rendering the drive unusable.

Should you decide that a low-level format is the way to go, there are a number of ways to accomplish this. Before you start, though, make sure that you have the correct informa-

tion for your drive and controller. You'll need to know the drive size, how many cylinders and heads the drive has, the write precompensation being used, the landing zone for the heads, and how many sectors per track the drive has. On the controller, you'll need to know if sector translation is taking place. If you're unfamiliar with any of these terms, you probably shouldn't be attempting to low-level format the drive.

Assuming your drive isn't an IDE unit, the low-level format can be accomplished by any of a number of software packages. Diagnostic packages like AMIDIAG (from AMI), CHECKIT 3.0 (from TouchStone Software), and QA/PLUS FE (from DiagSoft) all let you perform a low-level software. Actually, depending on your hard disk controller, the software for accomplishing this task may already be contained in the ROM on-board the controller card, and accessible with the DOS DEBUG program. Check your controller's documentation for this feature.

SpinRite II, from Gibson Research, gives you many of the advantages of performing a low-level format, with little of the potential for disaster. On any disk other than an IDE drive, SpinRite II actually performs a low-level format while maintaining the integrity of your data. It does this by performing the process one track at a time. The software first reads in an entire track of data, and while holding this data in memory, tests every bit on the track. While performing the low-level track by track format, it locks out sectors that are either bad, or which show indications of having a problem holding the magnetic charge. When the format of the track is completed, SpinRite writes the original data back onto the disk, and continues on to the next track. By performing this process every

couple of weeks, you ensure that your data doesn't occupy marginal areas of the hard disk. SpinRite II won't bring a dead hard disk back to life, but it will keep your hard disk in the best condition it can achieve. On IDE drives, SpinRite cannot perform the low-level format, but it does lock out marginal and bad disk sectors, moving your data to secure areas on the disk's surface.

Step 4: Add Cache (\$)

Finally, if you've tried all of the above, and your disks' performance is still lackluster, there's one last thing you can try before replacing the disk and controller. Disk caching involves setting aside an area of memory that will be used to buffer data going to and from the hard disk. This can be accomplished either by using a software package, like Multisoft's PC-KWIC (800/234-KWIC), which reserves a portion of the PC's RAM memory for this purpose, or a special hardware disk controller with cache RAM. Regardless of the approach that you choose, the

principle is the same. The caching software keeps track of which areas of the disk are used most often (written to or read from) and stores these areas in an area of RAM called the cache. When your program needs to perform a disk access, it first looks to this cache area to see if the information it needs to read or change is stored. If it is (called a cache hit), the program reads or writes to the cache, instead of the much slower electro-mechanical hard disk. If not (called a cache miss), the hard disk is accessed. The caching software continuously monitors this process, writing the cache area to disk after it has been changed one or more times, and bring new areas of the disk into the cache as your software accesses them frequently.

Caching, whether done entirely by software within your PC's RAM or with a caching hard disk controller, speeds up most disk-intensive applications like database, word processing, graphics, and desktop publishing. It has little effect, though, on applications like spreadsheets which don't frequently access the hard disk.

For many users, software that performs disk caching is an inexpensive way to gain the performance benefits, and can be several hundred dollars less expensive than the hardware approach. Be careful, however, with software disk caching. Using a software cache with Windows requires some software expertise to insure that your files don't become corrupted. Remember that even if you're using software to perform disk caching, the cache is going to require some amount of RAM to store the data in. If you are operating with a minimal amount of system RAM, you'll have to add memory to your system to make use of the RAM caching features.

And if you're using a large cache

Data Recovery Services

Backup Support Services, Inc.
419 Park Avenue South
New York, New York 10016
Telephone: (212) 686-6111

OnTrack Data Recovery
63-21 Bury Drive
Eden Prairie, Minnesota 55346
Telephone: (800) 872-2599

which doesn't frequently update the hard disk, a power failure, or even a glitch on the power line can play havoc with the integrity of your files. Hardware caching disk controllers tend to be somewhat more immune to these problems.

Step 5: File Compression

Even after you've tuned and tweaked your hard disk, you're likely to be somewhat dissatisfied with it. Regardless of how large it is, if it's more than just a few years old, chances are good that you're close to having it filled to capacity.

If you find yourself continuously deleting older applications to fit newer ones onto the disk, you might want to try a package such as STACKER, from Stac Electronics (800/522-7822). STACKER is a utility that compresses and decompresses data on the fly to and from your hard disk. It sets aside an area of the drive, defined by you during the setup, and modifies DOS to consider this compressed area as a logical hard drive. The entire compression/decompression process is entirely transparent to both your applications, and you.

There are two versions of STACKER. One is entirely software, and though it's very fast, may slow your applications down a bit. The second version includes a hardware coprocessor board to perform the compression and decompression. This is the faster version of STACKER. STACKER can, in some instances, almost double your disk space.

The amount of space you gain depends on your files. Program files don't compress much, while files like word processing and graphics can frequently be compressed down to about

half their original size. The only way to really find out is to get STACKER and try. But if you have a 20MB or 40MB hard disk that's starting to burst at the seams with files, STACKER is a good way to get some extra life out of it.

Know When To Pull The Plug

Regardless of which of the above techniques you use to breath new life into

your old hard disk, keep in mind that at some point you'll reach the point of diminishing returns. This is the point at which the original hard disk is just too small, and too slow to support the types of applications you need to run. When this happens, your best game plan is to simply upgrade, rather than try and boost the performance of what you have. Until you reach the point of no return, the approaches detailed above will let you get the most out of your existing hardware. ■

The Alpha Series 400 Caching Controller

The newest generations of hard disks, those that use IDE, ESDI, or SCSI interface technology, tend to be much faster than those drives that came before. But with today's very heavily disk intensive applications, even these fast drives often hit a performance wall. The answer in many of these cases is a caching hard disk controller card. With plenty of fast on-board RAM, the effect of adding one of these boards is immediately apparent with your most disk intensive applications.

Up until now, though, adding a caching disk controller to an existing PC meant that you had to back up the disk, as it needed to be reformatted to work with the new cache controller. A new vendor in the field, Alpha Research Corporation (8200 Mopac Expressway, Austin, TX 78759, 512/345-6465) recently introduced their Series 400 caching disk controller, the first "plug-and-go" cache controller which doesn't require that the existing drive be reformatted.

We installed a Series 400 IDE controller with 2MB on-board RAM

in a generic 486/33 with a 300MB hard disk. Outside of disconnecting the drive cable from the existing on-board controller and running a new cable from the Series 400 to the hard drive, the only thing we had to do was reset the drive type in the CMOS setup to TYPE 1. We rebooted and everything worked perfectly. Total time spent on the upgrade was about ten minutes.

Running our Real World Benchmarks before and after the upgrade, the results were about what we expected from our previous reviews of PCs with caching controllers. We saw dramatic gains in performance with those particular subtests that made frequent disk accesses, and no change in those tests (like the 1-2-3 tests) that are primarily CPU based.

At a retail price of under \$400 for the IDE controller (which should translate to just over \$200 on the street), plus about \$40 per megabyte of RAM, the Series 400 looks to us to be a must-have for any user with heavily disk intensive applications.

COMPARISON CHART: HARD DISK DRIVES GREATER THAN 105Mb & LESS THAN 150Mb

Make/Model	Drive Height	Drive Type	Form Factor	* Mounting	Formatted Drive Capacity	Average Seek Time	Avg. Track To Track	Data Transfer Rate	MTBF (hrs.)	Utility Software	Power Consumption (Watts)	Other Features	Works With	Price
CMS Universal B120A3	third-height	IDE	3-1/2 inch	I	121.7Mb	19ms	—	—	100,000	N	—	—	IBM PC, AT, & compats.	\$799
Plug 'n' Play B120A3-M3540	—	IDE	3-1/2 inch	I	120Mb	19ms	—	1.5Mbit/sec.	40,000	N	—	—	IBM PS/2 Models 35 & 40	839
ZeroSlot B120A-13	—	IDE	3-1/2 inch	I	120Mb	19ms	—	1.5Mbit/sec.	40,000	N	—	—	IBM PS/2 Model 30-286	909
Microscience International 7100-20	half-height	RLL	3-1/2 inch	I	120.4Mb	18ms	4ms	10Mbit/sec.	60,000	N	11	AT/IDE interface, on-board controller	IBM PC, AT, & compats.	\$495
5100-20	half-height	RLL	3-1/2 inch	I	123.8Mb	18ms	4ms	10Mbit/sec.	60,000	N	11	magnetic actuator lock	IBM PC & compats.	575
Quantum Corp. Hardcard II XL105	—	—	hard disk card	I	105.2Mb	17ms	5ms	—	—	N	7	fits into ISA/EISA 16-bit slot	IBM 286, 386, & compats.	—
Seagate ST3120A	—	RLL	3-1/2 inch	I	106.9Mb	16ms	3ms	12Mbit/sec.	150,000	N	5.1	computer simulated SeaCache algorithm	IBM AT & compats.	OEM only
ST3144A	—	RLL	3-1/2 inch	I	130Mb	16ms	3ms	14.5Mbit/sec.	150,000	N	5.1	computer simulated SeaCache algorithm	IBM AT & compats.	OEM only
ST3144N	—	SCSI	3-1/2 inch	I	126Mb	16ms	3ms	14.5Mbit/sec.	150,000	N	5.1	computer simulated SeaCache algorithm	IBM AT & compats.	OEM only
ST1144A	half-height	—	3-1/2 inch	I	130.7Mb	19ms	8ms	12Mbit/sec.	150,000	N	8	—	—	OEM only
Swift ST1133N	half-height	SCSI	3-1/2 inch	I	113.4Mb	15ms	4ms	10Mbit/sec.	150,000	N	11	—	—	OEM only

* I = Internal E = External All prices are U.S. suggested list. — = Information not available at press time. N/A = Not applicable

HARD DISK DRIVE MANUFACTURERS

CMS Enhancements Inc.
2722 Michelson Dr., Irvine, CA
92715, (714) 222-6000

Microscience International Corp.
90 Headquarters Dr., San Jose, CA
95134, (408) 441-1456

Quantum Corp.
500 McCarthy Blvd., Milpitas, CA
95035, (408) 434-6900

Rodime Systems
7700 W. Camino Real, Boca Raton,
FL 33433, (407) 391-7333

Seagate Technology
920 Disc Dr., Scotts Valley, CA
95066-6550, (408) 438-6550

Sysgen, Inc.
556 Gibraltar Dr., Milpitas, CA 95035,
(408) 263-4411

**Toshiba America Informations
Systems, Inc.**
9740 Irvine Blvd., Irvine, CA 92718,
(714) 583-3000, (800) 334-3445

Western Digital
8105 Irvine Center Dr., Irvine, CA
92718, (714) 932-4900

Make/Model	Drive Height	Drive Type	Form Factor	* Mounting	Formatted Drive Capacity	Average Seek Time	Avg. Track To Track	Data Transfer Rate	MTBF (hrs.)	Utility Software	Power Consumption (Watts)	Other Features	Works With	Price
Swift ST1150R	half-height	RLL	3-1/2 inch	I	128.4Mb	15ms	4ms	7.5Mbit/sec.	150,000	N	9	—	—	OEM only
Wren ST2125N	half-height	SCSI	5-1/4 inch	I	107Mb	18ms	4ms	9-15 Mbit/sec.	100,000	N	20	—	—	OEM only
ST4144R	full-height	RLL	5-1/4 inch	I	122.7Mb	28ms	6ms	7.5Mbit/sec.	40,000	N	23	closed loop linear voice-coil actuator	—	OEM only
Wren ST4135R	full-height	RLL	5-1/4 inch	I	115Mb	28ms	5ms	7.5Mbit/sec.	40,000	N	28	closed loop dedicated servo system	—	OEM only
Sysgen Mobile Disk 120	half-height	IDE	3-1/2 inch	E	120Mb	19ms	8ms	250Kbit/sec.	100,000	Y	12	attaches to computer's parallel port	IBM PC, XT, AT, PS/2, PS/1, & compats.	\$895
Toshiba MK-2124FC	half-height	IDE	2-1/2 inch	I	130Mb	17ms	5ms	15Mbit/sec.	80,000	N	1.8	—	IBM PC, AT, & compats.	OEM only
MK-1034FC	third-height	—	3-1/2 inch	I	107Mb	16ms	5ms	6Mbit/sec.	—	N	3.5	64K look-ahead cache	IBM PC, AT, & compats.	\$590
Western Digital Caviar II WDAC2120	third-height	RLL	3-1/2 inch	I	125Mb	15ms	6ms	15.4Mbit/sec.	100,000	N	5	32K cache, auto head parking	IBM AT & compats.	OEM only

How-to

Rebuild An XT And 286

If you opt for using every upgrade option available, the improved capabilities probably do not justify the expense. But, if you choose your upgrade options carefully, you might just end up with a reasonable outlay of cash for an outstanding improvement in performance.

Whether you're building from scratch or beefing up an older system, PC Upgrade editors tell you how, step-by-step.

For years, your trusty IBM-compatible XT or AT system served you well. Although it might not have all the horsepower you need today to run your Windows applications or other CPU-intensive software, it faithfully crunched your Lotus 1-2-3 spreadsheets, queried your dBase III database, generated pithy letters in Microsoft Word and deftly visualized your Harvard Graphics pie charts.

But now, you want more. In fact, you need more. Your customers demand more graphics-intensive reports. Your boss dictated that everyone in the office is migrating to a new software package that requires more horsepower than your current system delivers. Your department just spent a bundle on a color printer, but you have only a monochrome monitor.

Maybe you just feel its time to join the 1990s but your computer is stuck in 1985. You need to upgrade your system, but the overwhelming question is: build or buy.

Determining your needs

The easiest way to resolve this issue is simply to go to the nearest computer dealer, plunk down your checkbook or plastic, and walk out with a shining new system. While this certainly is the fastest way to solve your problem, it may not be the most prudent—for several reasons.

Buying a new computer from a computer dealer or discounter generally means that you get what the dealer is selling, not necessarily what you need. The best systems you can buy is one that meets your specific requirement.

You can determine your needs by asking yourself several questions.

They include:

- How do I use my system today?
- How do I expect to use my system in the next six months?
- What application software do I use most often?
- Do I expect to be using another application often?
- What special needs do I have in terms of data input and image or text output?

Once you answer these questions, you can better select which upgrades you need. For example, a user with a large database and lots of inquiries needs a fast hard disk with plenty of storage capacity, whereas a user who does serious number crunching needs a powerful CPU. And if you do graphics-intensive applications, you need a combination of ingredients: a powerful CPU, high-performance graphics card and monitor and possibly a color printer and plotter. Simply put: *You* know what you need to do to get

LIM
3/4

a job done. Your computer should reflect *your* needs; you shouldn't be at the mercy of your system.

Tools of the trade

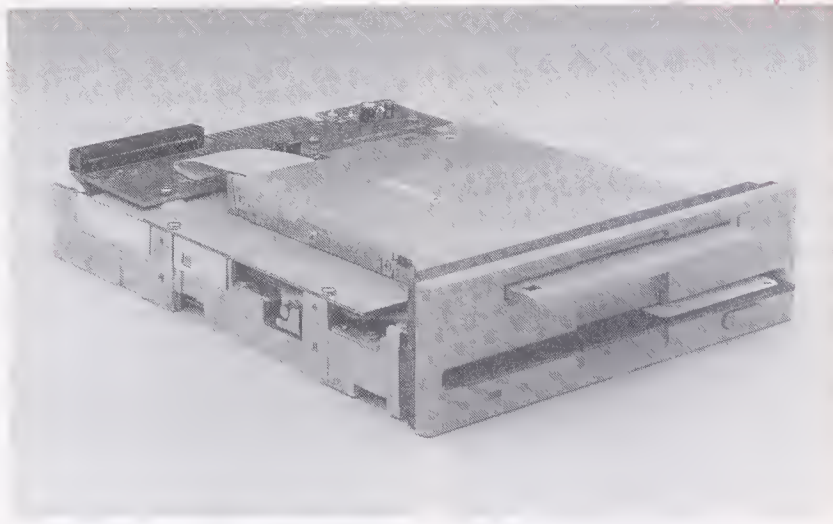
The hand tools you use inside your computer are very important. It is a wise investment to purchase a set of tools specifically designed for computer use. Generally, basic computer tool sets include non-magnetized Phillips and slotted screwdrivers, tweezers, a chip extractor (you can pick one of these up for less than \$3 in many computer stores), a chip setter (used for putting chips in once the pins are in place) and a mini-claw for picking up those errant screws that always fall where you can't reach them.

Such sets sell for approximately \$35 and are available through mail order, from computer dealers, from office supply stores and catalogs. I suggest that you add a mini-flashlight, a dental mirror, needle-nose pliers and two hemostats (one curved and one straight) to your kit.

Of course, you can also purchase more exhaustive kits that include soldering irons, continuity testers and other sophisticated equipment, but the basic set is all that is required for simple repairs and upgrades.

Upgrading the CPU and memory

Most of the XT-compatible systems in use today are "turbo" XTs running at 10 MHz. You can upgrade to an 80286 and keep your XT chassis by adding a 286 CPU accelerator board. The board fits into one of the bus slots, with a connector plugging into the old CPU's socket. You get the benefit of a faster CPU, but you still will be restricted to using only 8-bit expansion boards instead of 16-bit boards found in an AT.



New dual disk drives save a bay opening and cost little more than two drives bought separately.

Make sure your dealer will permit you to return the board if it does not fit your chassis. Not all motherboards have the same physical locations the screws that hold down the board to the chassis. If the screw holes don't match, you won't be able to install the new unit.

Adding additional memory also improves system performance by allowing data to reside in memory rather than on disk. If you have a 7Mb database, for example, you can transfer that file to memory, then run the program. Because the data is in semiconductor memory, operations happen virtually immediately rather than waiting for data to be moved to and from the hard disk.

The XT can directly address 1Mb of memory. However, the top 384K, or high memory, is reserved for hardware support, leaving the useable limit at 640K. If you add more memory to the XT, you must configure it as expanded memory. Up to 32 MB can be added using an expansion board that supports the Lotus/Intel/Microsoft (LIM) specification. Data stored in expanded memory is accessed through a 64 KB window lo-

cated in the high memory.

However, you might run into a software conflict if you run two programs that require the competing conventions for implementing the LIM specification. Lotus 1-2-3, AutoCAD and Paradox use the Virtual Control Program Interface from Phar Lap Software and Quarterdeck Office Systems. Windows implements Microsoft Corp.'s DOS Protected Mode Interface.

You should ask your dealer if the software you plan to use will be able to use expanded memory concurrently, such as running Lotus 1-2-3 as a Windows application. If not, you might want to use extended memory instead. If you must use expanded memory, you might be required to change the way you run your programs, such as exiting out of Windows before starting 1-2-3.

To see the real benefits of expanded memory, you need an application that requires expanded memory. If your software supports extended memory, you conceivably could configure your system with extended memory from the 1 MB threshold to 16 MB on a 286-based

LOOP
MEMORY286
Not
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X
X
XX
X
X
XX
X
X
X

Good
Memory

V.I.M.O. Mem. Up

↓
XT/AT 512/640 286/386

system (4Gb on a 386- or 486-based system), plus have 32Mb of expanded memory.

Extended memory is available only on 286, 386 and 486 systems. This memory requires no software drivers and is accessed directly by the CPU. If you have only extended memory but need to access it as expanded memory because of software requirements, you can use a LIM emulator, or "LIMulator." A LIMulator is a device driver that uses special memory mapping techniques of the 386 CPU to emulate expanded memory. It also is possible to use a hard disk as a LIMulator on an XT or AT, but the performance would be very slow.

The Intel Above Board Plus I/O, which can add up to 2Mb of expanded memory on an XT or up to 6Mb of extended memory, sells for \$300 with 0K of RAM. The board is socketed for eight banks of 256K DRAMs, with each bank using nine chips. A full, 2Mb board uses 72 chips. The board can be expanded to 6Mb using piggyback chips.

The price of memory chips is fluid, but you should pay less than \$5 a chip, and possible as low as \$2 per chip. Remember that when you buy memory chips, you need to buy a full bank of chips at one time. You system documentation will tell you how many banks can be filled at one time for the system to work. (All prices in the article are street prices found in selected computer stores across the country during April 1992. All products mentioned here are available through mail order or at computer dealers nationally.)

Remember that the XT motherboard is designed to support only up to 640K. The motherboard or system documentation will tell you what kind of chips to install—64K chips or a 256K chips—and where they go. If you upgrade your motherboard from

512K to 640K, remember to change the DIP switch on the motherboard to the proper setting for the new amount of memory. Your extended memory board documentation will tell you if other motherboard switch setting changes are required.

Much of today's software requires at least 640K of system RAM, and some requires more. It is a simple task to upgrade from 512K of RAM to 640K. Looking at a new chip, you will notice the pins are not pointing at a 90 degree angle to the chip; they bow out slightly. Place the chip on a table with all of the pins flat. With both hands, gently bend chip upright so that all of the pins are bent to a right angle to the chip at the same time. Then turn the chip over and straighten the pins on the other side.

You will notice that there is a small notch at one end of the memory chip. (All chips, including CPUs and BIOS chips, have a similar notch.) Note the orientation of the notch; there is a corresponding notch on the socket. The notch on the chip and the socket must be facing the same direction or you can damage both the chip and the motherboard.

You are now ready to insert the chip. But make sure all the pins fit into their sockets and the notch is in the correct orientation; a bent pin will foil your efforts. A chip inserter will aid you in making sure the chip goes in straight.

Motherboards

The best way to upgrade a 286-based AT to a 386 is replacing the motherboard. Although CPU upgrade boards and chips are available, some components on a 286 motherboard are not designed to perform at the higher speed of a 386 system. Nor can a 286 motherboard support all of the 386 memory management and other features.

From a cost standpoint, it's less expensive to replace the motherboard than buying an upgrade card and replacing components on the older board. Many CPU upgrade chips alone sell for from \$200 to \$500 (see related story in this issue). At that price, it is more cost effective to replace your aging system board with a faster, more technologically advanced motherboard designed to support the latest hardware and software.

Motherboards are available from computer dealers and through mail order. From a straight cost standpoint, you might find it less expensive to buy a baseline 386 system—a motherboard with CPU, 64K cache, 1Mb of RAM, one floppy disk drive (5.25-inch or 3.5-inch), an IDE controller, I/O card, power supply and chassis—than to buy the motherboard alone.

For example, Evergreen Computers International sells a 386-40 motherboard with a 64K cache and no RAM for \$335. (Expect to pay from \$50 to \$70 per Mb for RAM. These motherboards use SIMMs (single in-line memory modules), which are purchased as 1Mb or 4Mb modules.) Component Business Inc. sells a baseline 386-40 system with a 128K cache for \$545. Fry's Electronics, a large discount computer dealer and mail order firm in Silicon Valley, sells a 386-40 with a 128K cache motherboard with no RAM for \$599. Motherboards vary in quality, although it is not necessary to buy on the name brand alone.

Selecting which motherboard to buy can be confusing. Unlike disk drives or monitors, which are tested and compared regularly in many popular computer publications, motherboards get less attention in the press. Some manufacturers, such as Mylex Corp. or Micronics, have established their products based on

Boards + chips are chosen today

name brands. However, many excellent manufacturers, such as Addtech Research, sell their products through reseller channels, where the manufacturer's name is not seen on the board.

Despite the lack of a manufacturer's name on some motherboards, there are several indicators you can look for that suggest quality. These are indicators only, however, and not necessarily guarantees that the board is high quality.

The best advice is almost a cliché: always buy from a reputable source. If your supplier is Charlie's Auto Repair and Computer Store, chances are you're not getting top quality. However, if you select a supplier with a track record, either through mail order or a retail store, then you have a better chance of getting a product worthy of your system.

The second indicator—the layout of the components—is purely aesthetic, but it could indicate the design was well thought out. A motherboard that looks nice, with the memory and cache chips placed where they can be accessed easily when the board is installed, and very few jumpers and switches, means the designer took the design process personally. A clean design, with no hardwired connections on the back, means the manufacturer spent considerable in the initial stages of layout before the board ever got to the manufacturing process.

The thickness of the board also indicates quality. A thick board, six layers or more, is less likely to have errant electrical emissions than a thin board. Thick boards also indicate a higher level of integration, since the additional layers are needed for additional circuitry.

Compatibility is critical. If the board has more than one proprietary bus slot, you might want to think twice about making a purchase. Al-

though such slots might offer higher performance than Industry Standard Architecture (ISA) slots, it also means that you can't put an ISA board into that slot, effectively limiting your flexibility.

Always make sure that your supplier will take back the board if it is not compatible with your existing expansion cards. If not, you could get stuck with a board that you can't use.

Finally, look at the performance numbers supplied by the manufacturer. If all of the motherboards in a given class have the same general benchmark using one of the popular benchmark tools, such as PowerMeter or Landmark, you'll want to steer clear of a board with substantially lower performance figures running those same tests. If possible, test the motherboard using one of the system diagnostic tools, such as CheckIt from TouchStone Software Corp. Let the test run multiple times so you can see if there are intermittent errors.

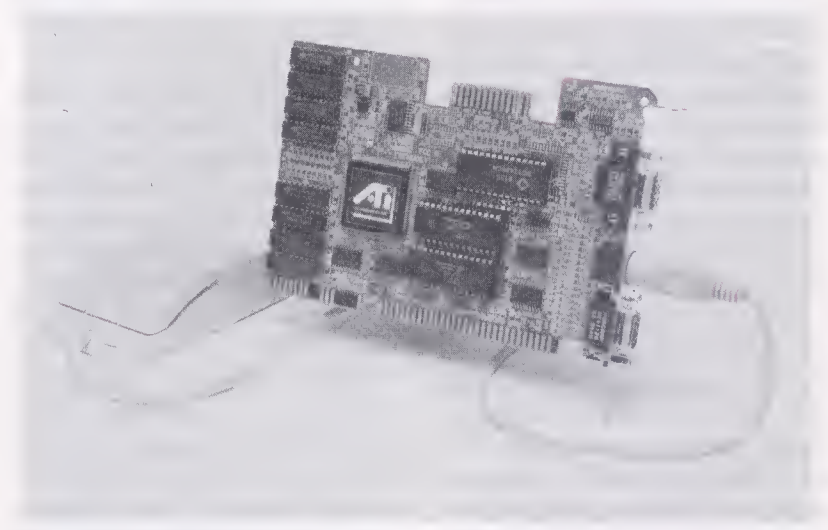
Math coprocessor

Interestingly, a math coprocessor probably won't improve your XT or

AT system's performance significantly. The coprocessor is designed for users who do math-intensive calculations, such as design work with computer-aided design or computer-aided manufacturing (CAD/CAM) software. The vast majority of PC-based spreadsheet software, such as Lotus 1-2-3, Microsoft Excel or Borland Quattro Pro, process most calculations more than adequately without the benefit of a coprocessor. For most users, the \$90 (80287) to \$210 (80387-33) is better spent on a larger disk drive or faster CPU.

Storage

All XTs had only 5.25-inch, 360K floppy drives, whereas ATs had a 5.25-inch, 1.2Mb floppy drive. If you want to install a 760K or 1.44Mb 3.5-inch drive, make sure your system's BIOS (basic input/output system) chip supports the drive. Many popular PC utility programs have programs that will identify the BIOS vendor's name and BIOS date. (With Norton Utilities or PC Tools, for example, the System Information program provides all or part of this infor-



The ATI XL video card automatically configures itself to your system. \$225.

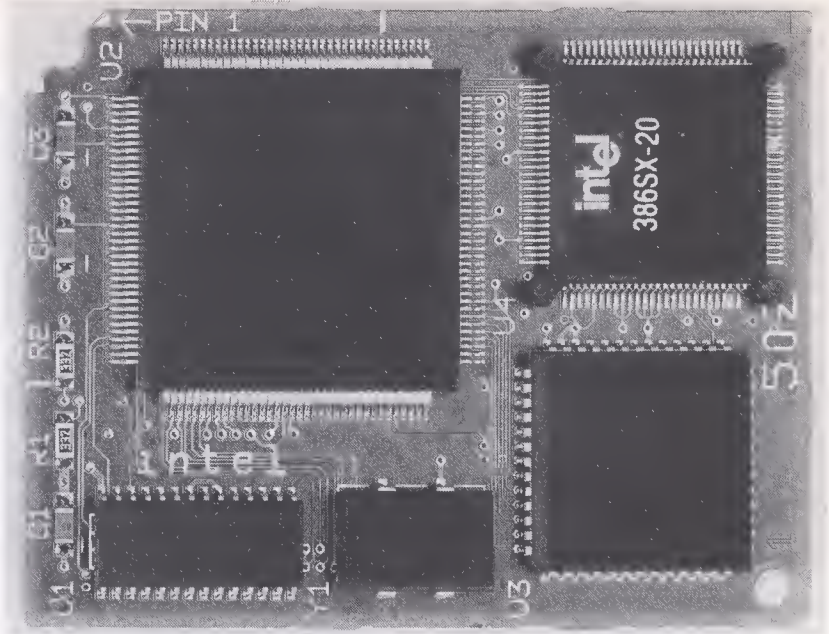
mation.) Ask your local computer dealer if this BIOS will support a 3.5-inch drive.

IBM didn't introduce its 1.44Mb, 3.5-inch floppy until three years after the debut of the AT. A new BIOS chip should cost approximately \$20 and is a direct replacement for your original chip. If you decide to add a 1.44Mb floppy to your system, you also have to upgrade your DOS to at least version 3.3.

Another option to upgrading your BIOS is buying a new disk controller that has its own BIOS that supports all current drives. If you currently have separate controllers for your floppies and hard disk, a new controller that supports both types of disks on the same card could free up a bus slot as well.

Adding a hard disk or a floppy is straightforward. If you already have one hard disk and are adding another, simply remove the chassis cover and find an available disk bay. If you already have one ST-506 drive installed, the new drive also must be an ST-506 disk. Simply attach the power supply cable (there's only one way to do this -- the right way), the control cable (the wide ribbon cable) and the data cable (the thin ribbon cable.) A single colored wire, generally red or blue, tells you which is the wire corresponds to Pin 1. Locate the corresponding connector on the disk controller; the connector has a 1 and 2 on one side, indicating Pins 1 and 2. Plug the cable into the connector with the red wire connecting to Pin 1.

If you want to move up to the IDE (Integrated Drive Electronics) drive, you will have to replace your hard disk controller with an IDE host adapter and remove any older hard drives. An IDE drive cannot coexist with an ST-506 drive, the type found in all XT's and older AT's. Up to two IDE drives can be attached to an IDE host adapter in a master/slave con-



Intel's SnapIn 386 line of microprocessor upgrades are made for both ATs and IBM PS/2 models, and are ideal for 386 compatibility, handling additional memory and Windows

figuration.

Until recently, you could not install an IDE drive on an XT. However, several 8-bit host adapters recently began appearing in stores. A 40Mb IDE drive sells for approximately \$225 with the 120Mb drive selling for closer to \$360 through mail order. (The host adapter, at \$20, is relatively inexpensive because the drive controller is built into the drive itself. The host adapter simply connects the drive to the system bus.)

Another way to increase disk space without buying a new hard disk is with a data compression package such as *Double Disk* (\$60) from Power Up! or *Stacker* (\$85) from Stac Electronics. Such packages can increase disk space from 100 to 300 percent, depending on the type of files you have.

Although IDE and SCSI (small computer system interface) drives can coexist, it is unlikely that you would install an expensive SCSI device on an XT or AT. One exception would be the installation of a CD-ROM. Most CD-ROMs, such as those from Chinon, NEC and Sony, are sold

with SCSI host adapter. This is important, because SCSI is not a plug-and-play interface; not all SCSI devices are compatible with SCSI host adapters. If you plan to add a SCSI device, such as a CD-ROM, ask your dealer to guarantee that the host adapter is compatible with the device, or that you can exchange it for one that is compatible. Up to seven compatible SCSI devices can be daisy-chained to the same host adapter.

Video cards

Upgrading from monochrome to color is a painless task, and it could offer side benefits as well. Many monochrome graphics boards include a parallel printer port, so make sure that if you remove this board you have another parallel port for your printer. (An I/O board with a parallel port, two serial ports and a game port generally sell for \$15 and can be installed in any open slot.)

Most VGA (video graphics array) video boards available today are 16-bit boards designed for 286, 386 or 486 systems. However, many can be

installed in an 8-bit XT without any modifications—several automatically configure themselves to the system without requiring you to set any switches.

Some of the best graphics cards on the market is from ATI Technologies. Its XL line (\$225 with 1Mb of video memory) can be used with any type of monitor ranging from monochrome to multi-frequency models and any type of system. The board automatically configures itself to the system, plus has the added benefit of a built-in mouse port and a high-resolution mouse.

A number of other fine models also are available for the XT and AT at prices ranging from inexpensive to very expensive. Among those available are the Cardinal 100 Plus (\$55 with 256K of video RAM) or the Orchid Technology Prodesigner IIS (\$200 with 512K and \$240 with 1 MB). AT and 80386 users running Windows will benefit from graphics cards with a Windows accelerator chip, such as the ATI Graphics Vantage (\$369 with 512K of video RAM, a built-in mouse port and mouse) or the Orchid Technology Fahrenheit 1280 (\$389 with 1Mb of video RAM).

Monitors

Super VGA (800 pixels x 600 pixels resolution) monitors are the norm today, with a number of vendors selling 1024 x 768 resolution monitors for the same prices as SVGA. When you shop for a monitor, check the dot pitch, or the size of each color pixel. The smaller the dot pitch, the clearer the image on the screen. The dot pitch should be no larger than 0.31 mm; many 14-inch monitors today, the most popular size for desktop computers, offer dot pitches of 0.28 mm or 0.26 mm.

The other consideration is whether the monitor is interlaced or non-interlaced. A non-interlaced monitor scans each line one at a time. An interlaced monitor scans every other line, then goes back and scans the lines it missed the first time. As a result, interlaced monitors could appear to flicker.

Many excellent interlaced and non-interlaced monitors are available, including the NEC 2A (\$430 interlaced), ViewSonic 4E (\$310 interlaced) and 5E (\$425 non-interlaced), Seiko 1450 (\$555 non-interlaced) and the Sony 1304S (\$560 non-interlaced).

Again, however, a caveat. Do not expect to see 1024 x 768 resolution on a 14-inch monitor. The laws of physics are not forgiving; they cannot be broken. At that resolution, the pixels are so small that a character on a 14-inch screen is unreadable. If you want to view this level of resolution, you must move up to at least a 16-inch monitor, and preferably a 17-inch or larger monitor. If your application requires this resolution, be prepared to plunk down \$900 or more for the monitor alone.

Regardless of how much money you pay for a graphics card and monitor, you won't be able to improve the readability of your application or the

number of colors available for image representations unless your software has a device driver to support these higher resolutions and colors. Before you buy, check the documentation of the software you use most to see if a device driver is provided or available. If not, you'll save money and get equally fine results with a less expensive monitor and graphics card.

Input devices

Your computing time can be miserable if you work with a keyboard that you don't like. Some are too mushy; others too stiff. Still other keyboards have an awkward key layout. And some are just plain uncomfortable.

Finding the right keyboard can make the difference between productivity and frustration. But not all keyboards work with every system. Some AT-class keyboards are not designed to work with XTs. Some keyboards have a small switch that must be moved from the XT mode to AT mode, depending on the system. I own several keyboards, including a 101-key extended keyboard that works fine with my seven-year-old XT, but won't work with the 386SX on my desk.

Finding the right keyboard is as simple as going to computer stores and trying them out. You might be accustomed to a double-wide backspace key, or the caps lock key under the tab key. Find one that feels good. I like the Focus 3001 (\$60), but selecting a keyboard is as personal as selecting a brand of coffee—most are palatable, but one is your favorite. Many quality keyboards are priced from \$30 to \$130.

One of the more unusual keyboards comes from DataDesk. Called the SwitchBoard, the \$160 keyboard is modular, meaning that you decide if it has functions keys across the top, left side or top and side; a track ball or



Sony CPD-1304S, \$560. Non-interlaced monitors like this Sony model offer crisp display and are flicker-free.



An upgradeable keyboard for your upgradeable PC! Switchboard keyboards from Datadesk Corporation allow you to arrange the alpha-numeric and cursor keypads into any of six different configurations. Plus, there is a trackball option.

numeric keypad; additional cursor keys or a 24-key, 3270-emulation keypad. You mix and match the options you want, or buy all the options and change them to suit your application.

A mouse can be a serial device that plugs into a free serial port or it can have a dedicated port that plugs directly into the PC bus. The bus version of the Microsoft Mouse sells for \$85, whereas the serial Logitech First Mouse sells for less than half that amount, approximately \$40. As noted earlier, you also can get a bus mouse bundled with a video card. Or, for the exotic, you can buy a cordless mouse that operates using an infrared beam.

If you have limited desk space, then the trackball is for you. Functionally a trackball is a mouse that goes nowhere. A variety of trackballs are available, however they tend to be more expensive than a mouse. The Logitech Trackman serial

trackball, for example, sells for \$73.

Communications

Now that you've upgraded your hard disk, thrown out that old keyboard and replaced it with a modern-day wonder, and installed a mouse, you're ready to log on to that on-line service and get some real work—or play—accomplished. But first, the modem.

Like just about every other decision you've made thus far, you have a wide choice of options here. Do you want an external, serial modem that transmits data at 2400 bits per second (bps) or an internal speed demon that zips data along at a brisk 14.4 Kbps.

Perhaps you want to send faxes directly from your PC. Then you need a fax/modem, which can be internal or external. Possibly you want to hook your computer up to your telephone and use it as a voicemail

system. Or maybe you have a fax machine and hate that thermal paper; you want a plain paper fax but don't want to spend \$2000 for a dedicated plain paper fax.

Adding an external modem, fax/modem or voicemail/fax/modem is as simple as plugging in a power cord, a cable into a free serial port and loading some software. Installing an internal model might require that a switch or jumper be reset on the motherboard; the documentation should tell you what you need to know about setting device addresses.

Modem prices have fallen dramatically recently. At the same time, most vendors are adding fax capabilities to modems. When you buy a modem today, the fax capabilities are virtually free.

Prometheus Products and The Complete PC are among those offering units with voicemail, fax and modem capabilities. Again, internal and ex-

ternal units are available. Installing one of these units allows the user to make a one-person office seem like a business with separate departments for technical support, sales, marketing, finance or any other department you can think of.

If you already own a laser printer, you can attach a device that sits between the fax phone line and computer and the printer. In the receive mode, incoming faxes are printed on plain paper. (Obviously, the printer must be left on to print any received fax.) The device ignores files sent from the computer to the printer, functioning as a simple junction box for the cable from the computer and the one from the printer. You also can add software that allows you to send faxes as well. Among those offering plain-paper fax devices are Technology Concepts and Tall Tree Systems.

Accessories

Remember too that when you upgrade, you can add a variety of accessories. Among them are an anti-glare screen, surge suppressors with separate on/off switches for your computer, monitor, printer and auxiliary devices; and swivel arms that move your monitor off your desktop, giving you more work space.

From the department manager's perspective, there is one accessory that could be invaluable. If you are upgrading more than one system, or if you are responsible for managing more than one system, you will want to know how each system is configured and component serial numbers for insurance purposes. You also will want to what software is installed on which system.

A kit called RE:ORGANIZE from Hartley & Associates will aid you in maintaining records on each system. The kit includes a utility disk to help you determine the hardware and soft-

ware configuration. It also includes some basic information on system maintenance and organization. The kit is available by mail order for \$40.

Build or buy

These are by no means the only hardware upgrades available. No discussion on upgrading a system can be complete without at least a mention of printers. If you haven't purchased a laser or other page printer, you should consider it now. Laser printer prices have fallen below \$700 for name-brand printers. You will want to consider this when budgeting for your system upgrades.

Multimedia is becoming the buzz word of the '90s—you can buy sound boards, multimedia graphics boards with build-in stereo capabilities or graphics boards and high-resolution monitors that combine to provide photographic-quality images. If you

need hundreds of megabytes of storage, you can add read-write, multi-function or write-once optical disk drives. And if you plan to input documents or images from other media, you can install color or monochrome flatbed or hand-held scanners.

Other potential upgrades include a tape drive to back-up your hard disk, a tower chassis, frame-grabbers, 2.88 MB floppies, removable hard disks, uninterruptable power supplies or—the ultimate—a 486-50 motherboard.

Remember, however, that the performance of your system is directly related to the speed of your CPU and peripherals. If you have very fast peripherals but a slow CPU, performance will suffer. Likewise, if you upgrade to a 386 CPU but keep your old 65 ms disk drive, your system will not show a performance boost during disk seeks or writes.

The question of whether you should upgrade your current system, buy a



A simple solution to your communications problems is a product like the Complete Fax/Portable, which offers modem and fax functions in a size no bigger than a transistor radio.

baseline system or buy a fully configured system should not be based on price alone, but rather, in relative order of significance, a combination of your software requirements, the time you can commit to upgrading your system, and, finally, price.

If you plan to run Windows, you should consider the upgrade carefully. Despite the claims that you need a 386 to run Windows, you don't. Windows will run fine on a 286 with at least 2Mb of RAM, but preferably 4Mb. A faster CPU will increase the performance, but that is

not required.

Desktop publishing software also requires 4Mb of RAM and a 386 CPU; in this case, it can be difficult to get acceptable results with slower processor.

Upgrading gives you the benefit of buying components one piece at a time, but you could be limited by the weakest link in the chain. If you upgrade from an XT to an AT by adding an accelerator board, you still are limited to an 8-bit data path. If you opt for a motherboard upgrade to a 286 or 386, you will need new memory chips as well. Either way,

you still can use your existing graphics card, keyboard, monitor and disk drives.

Buying a baseline or fully configured system probably won't save you money compared to buying each system component separately. While it will save you time in assembly, you lose the benefit of getting to know your PC intimately. Often, understanding how a PC is assembled and how each component interrelates to the others will save you time and money down the line, should the system require service. ■

Companies Featured

THE FOLLOWING LIST OF COMPANIES MENTIONED IN THIS ARTICLE REPRESENTS A SMALL FRACTION OF THE MANY DEALERS YOU CAN CHOOSE FROM WHEN LOOKING TO UPGRADE YOUR COMPUTER SYSTEM.

ATI Technologies Inc.
3761 Victoria Park Avenue
Scarborough, Ont Canada M1W 3S2
(416) 756-0718

Cardinal Technologies Inc.
1827 Freedom Road
Lancaster, PA 17601
(717) 293-3000

Chinon America Inc.
Information Equipment Division
660 Maple Ave
Torrance, CA 90503
(213) 553-0274

The Complete PC
1983 Concourse Drive
San Jose, CA 95131
(408) 434-0145

Component Business Inc.
41340 Christy Street
Fremont, CA 94538
(510) 651-6256

DataDesk
9524 S.W. Tualatin-Sherwood Road
Tualatin, OR 97062
(503) 692-9600

Evergreen Computers International Inc.
2700 Rydin Road, #C
Richmond, CA 94804
(510) 526-8667

Focus Electronic Corp.
9080 Telstar Ave.
Suites 302-304
El Monte, CA 91731
(818) 280-0416

Fry's Electronics
1177 Kern Ave.
Sunnyvale, CA
(408) 733-1770

Hartley & Associates
4101 Westerly Place
Suite 105
Newport Beach, CA 92660
(714) 476-1916

Intel Personal Computer Enhancement Operation
CO3-7
5200 N.E. Elam Young Parkway
Hillsboro, OR 97124
(800) 538-3373, (503) 629-3373

Logitech
6505 Kaiser Dr.
Fremont, CA 94555
(510) 795-8500

Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
(206) 882-8080

NEC Technologies Inc.
Computer Products Division
1414 Massachusetts Ave.
Boxborough, MA 01719
(508) 264-8000

Orchid Technology
45365 Northport Loop West
Fremont, CA 94538
(510) 683-0300

Power Up!
P.O. Box 7600
San Mateo, CA 94403
(800) 851-2917

Prometheus Products
9524 S.W. Tualatin-Sherwood Rd.
Tualatin, OR 97062
(503) 692-9600

Sony Corp. of America
655 River Oaks Parkway
San Jose, CA 95134
(800) 352-7669

Stac Electronics
5993 Avenida Encinas
Suite 101
Carlsbad, CA 92008
(619) 431-7474

Tall Tree Systems
2585 E. Bayshore Road
Palo Alto, CA
(415) 493-8324

Technology Concepts
1159 Triton Drive
Foster City, CA 94404
(415) 349-0900

ViewSonic Corp.
12130 Mora Drive
Santa Fe Springs, CA 90670
(800) 888-8583

COMPARISON CHART: SCANNERS UNDER \$1,400

Make/Model	* Feeder Type	Software Included	Font Recognition	Levels of Gray	Number of Colors	Resolution (dpi)	Auto-fed Sheets	IBM PC-compatible	Macintosh-compatible	Other Features	Price
Canon IX-30F	F	none	opt.	256	N/A	75/150/200/300	opt.	Y	opt.	small footprint	\$1,545
Complete PC The Complete Half Page Scanner 400	H	MasterScan	opt.	16 simulated	N/A	200/300/400	N/A	Y	N	incl. interface card	\$199
The Complete Half-Page Scanner/GS	H	Picture Publisher	opt.	256	N/A	100-400	N/A	Y	opt.		349
The Complete Half-Page Scanner/Macintosh	H	SmartScan	opt.	256	N/A	200/300/400	N/A	N	Y	incl. MacScanner interface	399
The Complete Page Scanner	S	MasterScan	font trainable	16 simulated	N/A	200/300	N/A	Y	N	incl. interface card, MasterScan software	899
The Complete Page Scanner (Macintosh)	S	MasterScan	opt.	16 simulated	N/A	200/300	N/A	N	Y	incl. Mac Scanner interface	999
The Complete Page Scanner/GS	S	WordScan OCR, Picture Publisher	font trainable	256	N/A	200-300	N/A	Y	opt.	compact size	1,099
DEST Personal Scan PAC	S	Recognize! OCR software, Image-In/Scan & Paint Graphics	font trainable	64	N/A	300	10	Y	Y	incl. PC interface card	\$799
DFI HS 3000-Plus	H	none	—	32	N/A	100-400	N/A	Y	N	weighs 5 oz.	\$259
CHS-4000	H	ZSoft PC Paintbrush IV plus, utilities	—	—	256	400	N/A	Y	N	incl. 16-bit ISA interface card	695
Logitech ScanMan Model 256	H	Auto Stitch Image Editing software, Perceive Personal OCR bundle	font trainable	256	N/A	100-400	N/A	Y	N		\$549

F = Flatbed S = Sheetfed H = Handheld All prices are U.S. suggested list. — = Information not available at press time. N/A = Not applicable

Make/Model	* Feeder Type	Software Included	Font Recognition	Levels of Gray	Number of Colors	Resolution (dpi)	Auto-fed Sheets	IBM PC-compatible	Macintosh-compatible	Other Features	Price
Marstek ColorArtist	H	Rainbow Studio-Perceive OCR software	font trainable	64	262,144	100-400	N/A	Y	N		—
ImageArtist	H	PC Paintbrush-Perceive OCR software	font trainable	64	N/A	100-800	N/A	Y	Y	incl. merge function	\$299
Mars 800 - Mac 64	H	Enhance software	—	64	N/A	100-800	N/A	N	Y		549
Pentax IQ Scan	F	WordScan OCR software	font trainable	16	N/A	39-300	opt.	Y	Y		\$995

SCANNER MANUFACTURERS

Canon, U.S.A., Inc.

One Canon Plaza, Lake Success, NY
11042, (516) 488-6700

Complete PC, The

Concourse Dr., San Jose, CA 95131,
(408) 434-0145

DEST

1015 E. Brokaw Rd., San Jose, CA
95131, (408) 436-2700

DFI

2544 Port St., West Sacramento, CA
95691, (916) 568-1234

Logitech, Inc.

6505 Kaiser Dr., Fremont, CA 94555,
(510) 795-8500

Marstek

17785 Skypark Circle, Ste. A, Irvine,
CA (714) 833-7740

Pentax Technologies

100 Technology Dr., Broomfield, CO
80021, (303) 460-1600

COMPARISON CHART: LASER PRINTERS UNDER \$1,500

LASER PRINTERS

Make/Model	Pages Per Minute	Bit-mapped Graphics	Internal Memory	Emulation/ Page Description Language	No. Built-in Fonts	Character Sets	Rotatable Fonts	Font Cartridges	No./ Cap. Input Bins	* Face-up/-down Output	Envelope Feeder	Toner Life (in pp.)	Other Consumables	Dimensions (H X W X D) (in.); Weight (lb.)	Inter-face	Price
C-Tech C14PPM	4	—	512K	HP PCL	14	—	—	cartridges	1; 20	—	—	—	—	7.7 X 14.3 X 15.9; 28.7	P, S	\$1,245
Eastman Kodak EKTAPLUS 7008	8	—	1.5Mb	HP PCL, HP GL	14	—	—	cartridge	1; 200	Both	—	1,500	drum	8.8 X 15.4 X 16.1; 37.5	P, S	\$1,395
Epson America ActionLaser II	6	Y	512K	HP PCL4	9	—	—	cartridges	1; 150	Both	—	1,500	drum/charger unit	8.3 X 16.1 X 15.4; 36	P, S	\$999
GCC PLP II	4	Y	—	QuickDraw; opt. PostScript	—	N/A	Y	N/A	—	—	Y	—	EP magazine	5.25 X 17.7 X 17.7; 24	SCSI	\$999
PLP IIs	8	Y	1Mb	QuickDraw; opt. PostScript	13	N/A	Y	N/A	—	—	Y	—	EP magazine	5.25 X 17.7 X 17.7; 24	SCSI	1,499
Hewlett-Packard HP LaserJet IIP plus	4	—	512K	HP PCL4	14	—	—	cartridges	1; 70	—	Y	3,500	—	—	P	\$1,249
IBM (Lexmark) LaserPrinter E	5	Y	512K; opt. 3.5Mb	HP PCL, IBM GL, HPGL; opt. PostScript	—	—	—	—	1; 200	—	opt.	—	—	10.2 X 14.2 X 20; 33.6	P, S	\$1,495/1,994 (PostScript)
Okidata OL400	4	Y	512K	ASCII	17	—	N	HP-compat.	1; —	D	opt.	2,500	—	5.25 X 17.7 X 17.7; —	P, S	\$999/1,199
OL 800	8	—	512K	HP PCL, IBM Proprinter, Diablo 630 ECS	26	—	—	N	—	D	Y	2,500	image drum cartridge	8.5 X 17.7 X 7; 37	P, S	1,499/1,699
Panasonic KX-P4430 Laser Partner	5	Y	1Mb	HP PCL5	28	—	N	cards	1; 200	Both	Y	3,000	developer, drum	9.3 X 14.6 X 15.5; 30.9	P; S	\$1,495

* U = Up D = Down All prices are U.S. suggested list. — = Information not available at press time. N/A = Not applicable

Make/Model	Pages Per Minute	Bit-mapped Graphics	Internal Memory	Emulation/ Page Description Language	No. Built-in Fonts	Character Sets	Rotatable Fonts	Font Cartridges/ Card	No./ Cap. Input Bins	* Face-up/down Output	Envelope Feeder	Toner Life (in pp.)	Other Consumables	Dimensions (H X W X D) (in.); Weight (lb.)	Interface	Price
Qume CrystalPrint Series II	6	Y	512K; opt. 1Mb	HP PCL	2	ASCII, Roman	Y	proprietary	1; 100	D	N	6,000	drum	9.1 X 15.7 X 13.4; —	—	\$1,499
Sharp JX-9500H	9	—	512K	HP PCL, Epson FX-80, IBM Proprinter, Diablo 630	6	—	—	HP- compat.	1; 250	Both	Y	—	—	10.5 X 13.4 X 14.2; 33.5	P, S	\$995
Star Micronics LaserPrinter 4	4	Y	1Mb	—	151	N/A	Y	Y	1; 50	Both	Y	3,500	—	7.3 X 16.4 X 15.2; —	P, S	\$1,395
Texas Instruments microLaser Plus	6	Y	.5Mb	HP PCL	8	—	Y	Postscript, Diablo 630, Epson FX	2; 250	Both	opt.	3,000	OPC, developer	10.9 X 13.4 X 14.2; 33.5	P, S, Apple Talk	\$999
microLaser Plus PS 17	9	Y	1.5Mb	HP PCL, Postscript (17 fonts)	9	—	Y	Diablo 630, Epson FX	2; 250	Both	opt.	3,000	OPC, developer	10.9 X 13.4 X 14.2; 33.5	P, S, Apple Talk	1,399
microLaser Plus PS 35	9	Y	1.5Mb	HP PCL, Postscript (35 fonts)	9	—	Y	Diablo 630, Epson FX	2; 250	Both	opt.	3,000	OPC, developer	10.9 X 13.4 X 14.2; 33.5	P, S, Apple Talk	1,499

LASER PRINTER MANUFACTURERS

C-Tech Electronics, Inc.
P.O. Box 19673, 2515 McCabe Way,
Irvine, CA 92713-9673, (800) 347-
4017, (714) 833-1165

Eastman Kodak Co.
Personal Printer Products, 901 Elm
Grove Rd., Rochester, NY 14653,
(800) 255-3434

Epson America, Inc.
20770 Madrona Ave., P.O. Box 2842,
Torrance, CA 90509, (213) 782-0770
(800) 289-3776

GCC Technologies
580 Winter St., Waltham, MA 02154,
(617) 890-0880, (800) 422-7777

Hewlett-Packard
Co. Inquiries, 19310 Pruneridge Ave.,
Cupertino, CA 95014, (800) 752-0900

IBM: see Lexmark International

Lexmark International
740 New Circle Rd., Lexington, KY
40511, (800) 426-2468

Okidata
532 Fellowship Rd., Mt. Laurel, NJ
08054, (609) 235-2600

Panasonic Communications & Systems Co.
Two Panasonic Way, Secaucus, NJ
07094, (800) 843-0080

Qume Corp.
500 Yosemite Dr., Milpitas, CA
95035, (408) 942-4000; (800) 223-
2479

Sharp Electronics Corp.
Sharp Plaza, Mahwah, NJ 07430-
2135, (201) 529-8200

Star Micronics America, Inc.
420 Lexington Ave., Ste. 2702, New
York, NY 10170, (800) 447-4700

Texas Instruments
(Information Tech. Group), P.O. Box
202230, Austin, TX 78720-2230,
(800) 527-3500, (512) 250-7111

VGA MONITORS UNDER \$400

Make/Model	Analog/TTL	Display Area (in. diag.)	Maximum Resolution	Dot Pitch (mm)	Scan Freq.: Horiz. (kHz); Vert. (hz)	Interlaced/ Noninterlaced
Amdek AM/432LC	A	14	640 X 480	—	31.5; 60/70	—
AM/732LC	A	14	640 X 480	.39	31.5; 60/70	—
AM/732+	A	14	640 X 480	.28	31.5; 60/70	—
AOC International MM-413L	A	14	640 X 480	—	31.5; 60/70	—
CM-333MG	AT	14	640 X 480	.39	31.5; 60/70	—
AST Research Monochrome VGA	—	14	720 X 480	—	31.5; 56/60/70	Non.
Copam 1400/30LR	AT	14	1024 X 768	.28	31.5/35.2/35.5; 50-90	—
GoldStar 1220W VGA	A	12	640 X 480	—	31.5; 50/60/70	—
1403 Plus	A	14	640 X 480	—	31.5; 50/60/70	—
Samtron SM-470	A	14	640 X 480	—	31.5; 60	—
SC-441V	A	14	640 X 480	.41	31.5; 60/70	—
Wyse WY-550	AT	14	640 X 480	—	31.5; 60/70	—
Xtron CM 1402E	A	14	1024 X 768	.28/.31	31.5; 50/60/70	Non.

VGA MONITOR MANUFACTURERS

Amdek
3471 N. First St., San Jose, CA
95131, (408) 473-1200, (800) 72-
AMDEK

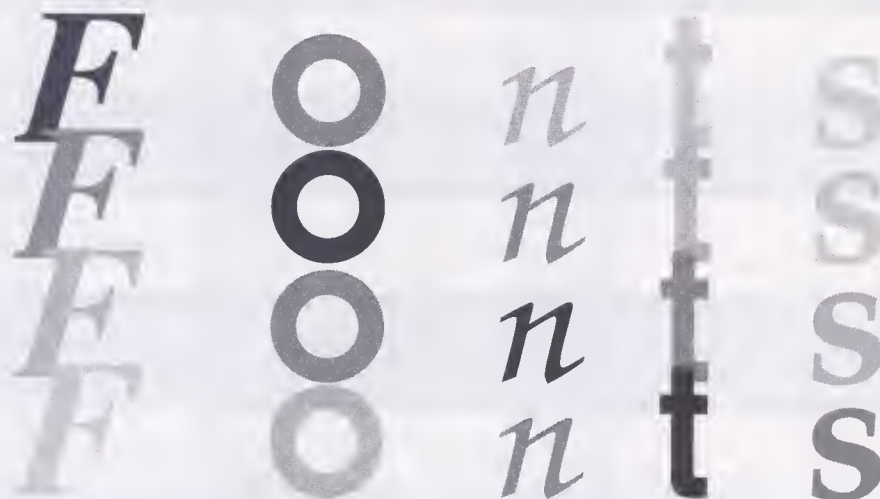
AOC International
10991 N.W. Airworld Dr., Kansas
City, MO 64153, (916) 691-8066

AST Research, Inc.
16215 Alton Pkwy., P.O. Box
10658, Irvine, CA 92713, (714)
727-4141

Copam USA, Inc.
45875 Northport Loop E., Fre-
mont, CA 94538, (510) 623-3211,
(800) 828-4200

Unless otherwise noted, all monitors support 80-character by 25 line text display. N/A = Not applicable

All About



by Stephen Hutson

So you have entered the wonderful world of Windows 3.0; you have conquered the GUI, OLE, and DDE; you have bought every SIMM you could find in order to have enough RAM to run Windows, and you have done whatever was necessary to find the hard disk space for those large Windows applications. Now, as a reward for all your efforts, you have six basic fonts. Of these, there are only three you would ever use on a normal document, and some of these will probably not print out properly on your printer. If you have a Postscript printer, you have access to 35 typefaces and are probably asking what all the fuss is about. If you, like most of us, are struggling to get by with a dot matrix or basic-featured laser printer, read on.

One of the advantages of the graphical environment is what has become a buzz word in computer circles—

WYSIWYG (What you see is what you get).

Prior to Windows and other WYSIWYG applications, everything you saw on your monitor was character-based; that is, the computer had 128 characters to choose from and they basically comprised the upper case alphabet, the lower case alphabet, numerals, basic punctuation, and a few line drawing characters. If you wanted italics, bold face, or underlining, you instructed the computer to make the change and hoped it came out that way on the printout, because you could not see such changes on the monitor. WYSIWYG gives you the ability to work with various fonts and know that the results on the monitor will match the printed document. In this article, we will examine the subject of fonts and consider several different ways to increase your available fonts.

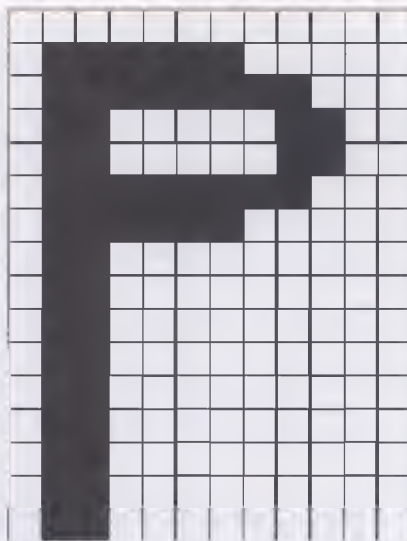
Screen Fonts vs. Printer Fonts

Before we can begin to take advantage of the WYSIWYG environment, we need to understand the difference between screen fonts and printer fonts. The six default Windows fonts are screen fonts; that is, a font designed for display on your monitor. Windows will substitute the closest font available on your printer, but sometimes that is not very close. In order for Windows to be truly WYSIWYG, you need screen fonts that match your printer fonts. Furthermore, for this to be really effective, the metrics (height and width) of the screen fonts must match the printer fonts, otherwise line breaks and page breaks will occur at unexpected places, and columns lined up with tabs on the monitor will not be lined up properly on the printout.

Screen fonts can be created in one of two ways; they can be stored as bitmaps on the hard drive or created as needed in memory. Figure 1 illustrates how a letter is stored as a bitmap. Each square (often called a pixel) is assigned a value of 1 or 0. Those squares with a value of 1 are filled; those with a value of 0 are not. The bitmap format can be faster than screen fonts created in memory, but they can also take amazing amounts of real estate on your hard drive. (A typical screen font file will take about 70 KB of disk space. If you have six typefaces that you will be using in three different sizes, screen fonts will take up about 1.3 MB of your hard disk.) Creating screen fonts in memory does not take any disk space, but you will have to wait for the computer to create each character as you type it. This is a good option unless you are a very fast typist or have a very slow computer. As an example, I type 65 wpm on a 386/33 and have no problem with the computer keeping up with my typing. If you are using a 286/10 or slower, and type more than 75 wpm, you will probably have to stop now and then and give the computer a chance to catch up.

Of Vectors and Rasters

There are two different ways to store printer fonts on a computer—as a bitmap (also known as a raster font) or as a scalable font (also known as a vector font). Bitmap fonts are convenient in that they draw no resources from the CPU of your computer; they are stored on the disk drive, sometimes read into memory, and inputted as requested. As with bitmap screen fonts, though, they consume disk space with a voracious appetite. As illustrated in the figure, a bitmap font breaks the area reserved for a letter into a grid and tells



Bitmap fonts break the area reserved for a letter into a grid and instruct the printer to turn each square of the grid on or off. The result can be the “jaggies,” where diagonals and curves look like stair steps.

the printer to turn each square of the grid on or off.

The main problem with bitmap fonts is that they only look correct at the size they were designed. When the desired size is not stored on the disk drive, the computer must decide which squares will be filled; the result is the “jaggies,” where diagonals and curves look like stair steps. There are only two solutions to this problem—use a smaller number of font sizes or store more sizes on the hard disk. The result is usually a compromise, with you, the user, holding the short end of the stick. For example, this article is printed in 10 point Times Roman. You’d need another entire set of fonts to use 12 point Times Roman, another to use 10 point Times Roman Bold, another for 12 point Times Roman Bold Italic, ad infinitum. How do you decide how many fonts is enough, and how many take up too much disk space?

The other option for storing fonts is the vector font. In this case, the font is stored as a set of drawing instructions (for our capital P, start at point a; draw a line 65 units long at 360°; then draw a line 15 units long at 90°; then draw an arc circumscrib-

ing 180° with a radius of 10 units; then draw a line 15 units long at 270°). When you send your job to the printer, either the CPU of your computer or the controller in your printer interprets these instructions and converts them to the only thing a printer truly understands—a series of dots. This process is called rasterizing.

The advantage of this method is that only one set of instructions is needed for any typeface; the units can be adjusted mathematically to create the same letter at any size. The disadvantage is that you may notice longer print times as the rasterizing is completed.

This is where a good print spooler pays for itself. A print spooler stores the information needed to complete a print job on your hard disk and gives you two options—either split the CPU time and multitask the print job with your other work, or print all your work in a batch job later when the computer is not busy, for example, during your lunch. There are good print spoolers on the market that were designed for the Windows environment, and one of the font managers we will discuss later includes a good print spooler. The

Print Manager included with Windows is a print spooler, but not a good one; it is not much faster than printing directly.

Downloadable Bitmap Fonts

There are several ways to purchase additional fonts for the Windows environment; the most common are downloadable bitmap fonts, cartridge fonts, and scalable font managers. Downloadable bitmap fonts are stored on a diskette, which you then copy to your hard disk. Before you send the job to the printer, you download the fonts, that is, you copy the fonts to your printer's memory. The printer then uses these fonts to print your document.

The limitation to this method is that, just as bitmap fonts take up space on your hard drive, they take up room in your printer's memory. Often, this means purchasing extra memory for your printer at a cost of about \$100 per megabyte. However, if you have adequate disk space and printer memory and do not require a large variety of font sizes, downloadable bitmap fonts will provide you with a satisfactory font solution.

Cartridge Fonts

The second font solution is cartridge fonts; these fonts are stored on a ROM (Read Only Memory) chip contained in a cartridge that plugs into your printer. These fonts are generally bitmap fonts that are packaged with a diskette containing matching screen fonts. Although you are limited in the number of sizes that will be contained in the cartridge, this is a good font solution for the person who does not want to purchase extra printer memory and has limited disk space. You will only

need space for the screen fonts; the printer fonts are contained in the cartridge.

One of the real advantages of this solution is the simplicity of installation—plug the cartridge in, copy the screen fonts to your hard disk, and run the Control Panel program to tell Windows which cartridge is installed. Before you purchase any type of cartridge fonts, make sure that the cartridge is compatible with your printer and with the applications you will be running.

Scalable Font Managers

The most flexible fonts for the Windows environment are the scalable fonts available from font managers.

A font manager is a software program that handles all the intricacies of vector fonts—installing, scaling (changing the size of a font without changing the other characteristics of the font), rasterizing (converting the vector font to a bitmap for output to the printer), and sometimes spooling (saving your output file to a temporary file on the hard disk, so that you can continue to work while the file prints). If you have enough RAM in your computer (usually 2Mb) and your printer (usually 1Mb for a laser printer), a font manager is definitely the way to go. Most programs give you several fonts as part of the basic package, and the ability to add any other fonts that may be needed later.

Depending on the specific situation, I generally recommend one of three—Adobe Type Manager, Bitstream's Facelift, or Zenographic's SuperPrint.

Adobe Type Manager

ATM is, by sales volume, the industry leader in Windows fonts. It is available at a reasonable price, in-

cludes the basic typeface families in the package, and can be purchased in a bundle with several software packages (like Aldus PageMaker). Of all the font managers reviewed here, it is by far the easiest to install and use. Also, it is published by Adobe, the people who wrote the PostScript standard; they know fonts. ATM gives you access to all fonts written according to the PostScript Type I standard.

To install ATM, insert the disk, type "Install" in the **File • Run** dialog box, and change the disks when instructed. To add more fonts later, copy the fonts to the hard disk, double-click on the ATM logo to run the configuration program, select the directory containing the new fonts, and click on the "Add" button. With its ease of installation, its access to thousands of typefaces, and its compatibility with almost every Windows program, ATM is a great value.

Bitstream Facelift

Facelift is a solid scalable font manager with no noticeable flaws. Its hardware requirements are as low as any product in this lineup. Although it is only compatible with Bitstream published fonts, there are many of those available. While it does not include print spooling, it does a good job of managing scalable fonts.

This product shines in situations where you have a minimum of memory (1 MB on your computer and 512K on your laser printer) and you still want to use scalable fonts. Because of its low hardware requirements, it tends to work in situations where the other products discussed will fail.

If you have the necessary hardware, either ATM or SuperPrint will probably give you more of what you are buying a scalable font manager for.

Windows 3.1 True Type

As this article was nearing completion, Microsoft upset the apple cart somewhat with the introduction of Windows 3.1. This latest release of the Windows environment includes a scalable font manager called TrueType. To what extent does this new version of Windows do away with the need for a supplemental font manager?

First, TrueType will be a powerful contender in the field of scalable font managers because of its cost. Free (or at least included in the cost of Windows) is a powerful incentive in any market. However, be aware that, in spite of the improved quality of the TrueType fonts included with Windows, there are still only five TrueType fonts included with Windows.

Second, TrueType promises to be an exciting addition to the world of Windows because of its open

architecture. Microsoft has published the technical specifications of TrueType so that other vendors can offer TrueType fonts. It has generally been true that a well-written specification marketed by a company that has market clout will be accepted *if* the specifications are made available to other vendors.

The certainty of competition provides the promise of low prices and quality fonts in the near future. Also, certain printer companies (for example, Printer Works in Hayward, CA) are already releasing printers with Truelmage, the hardware equivalent of TrueType. Because a Truelmage printer will have built-in TrueType fonts, it should enjoy a slight speed advantage over non-Truelmage printers printing TrueType fonts.

Finally, it remains to be seen how

the publishers of current scalable font managers will react to the release of Windows 3.1. This situation is reminiscent of the release of DOS 5.0, when the publishers of memory managers saw DOS attempting to take over a market that had always been left to third party vendors. They immediately found areas where DOS 5.0 was insufficient and modified their products to meet this new need.

We will have to wait and see how the publishers of font managers react to this new challenge from Microsoft.

Third, PostScript is not going to go away anytime soon. PostScript still offers a speed advantage over TrueType, since it is hardware-based, rather than software-based. It also offers improvements in graphics printing which is not addressed in TrueType. ☐

Zenographic SuperPrint

SuperPrint is the most versatile font manager on the market; it currently supports fonts from six major font specifications. Among these specifications are Hewlett-Packard fonts, Postscript Type I fonts, and Bitstream fonts. Besides all this, it also provides output to LaserJets and HP-compatible laser printers, DeskJet printers, dot matrix printers, and several high resolution output devices.

In addition to its wide range of supported devices, SuperPrint includes print spooling in its bag of tricks. With only a few exceptions, the print spooler is far more efficient than the Print Manager included with Windows. The exception is spreadsheet printing, specifically the printing of landscape spreadsheets with cell borders. Despite recent improvements in the latest version, it is still

abysmally slow in this one area. Its treatment of graphics provides faster printing and better-looking output than any other package discussed.

One final caution. My experience with SuperPrint has involved a call to technical support almost every time I have added any software or hardware to my system. These calls usually result in a call back within a day or so (rather than an hour or so). There is still a basic incompatibility with the Equation Editor in Word for Windows 2.0 and with the Diamond Stealth video card. In spite of these difficulties, this product offers a great number of services in one package.

Summary

Even though fonts are just letters to us, they were designed by an artist who had to decide what the font should look like and how best to

instruct the computer to generate that font. Scalable fonts provide the best opportunity to use those fonts to improve the appearance and readability of everything we produce on the computer. ■

Font Mfrs Featured

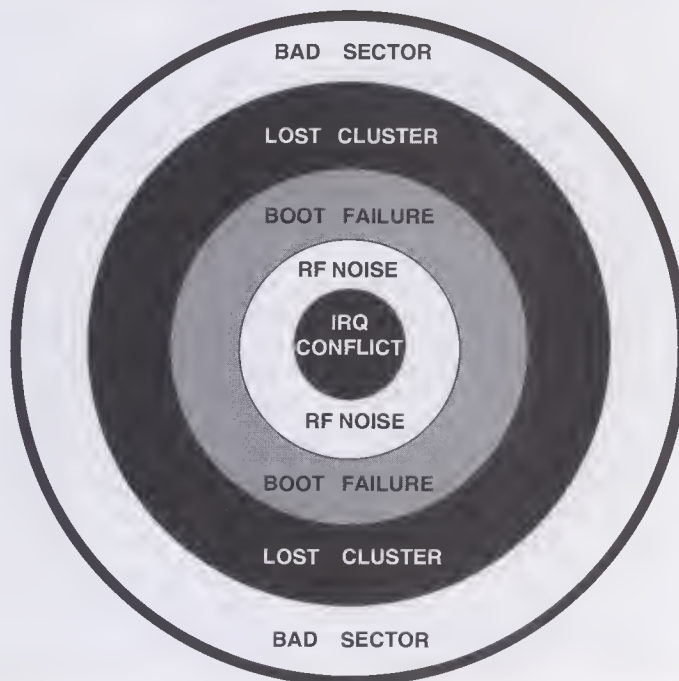
Adobe Systems Inc.
1585 Charleston Road
P.O. Box 7900
Mountain View, CA 94039
(415) 961-4400

Bitstream
215 First Street
Cambridge, MA 02142
(617) 497-6222

Zenographics
4 Executive Circle
Irvine, CA 92714
(714) 851-6352

Troubleshooting Your System

The editors target hard disks, floppy drives, power supply, monitors, modems, and more.



Whenever you begin to repair a computer, PLEASE follow these safety steps to avoid severe injury, and/or damage to your equipment.

1. Always unplug the power cords for BOTH the computer and the monitor before opening the casing on your computer.
2. Never close the computer up again without first inspecting every inch for a dropped screw, broken wire, or worst of all, a forgotten screwdriver.

Your computer has gone down, and you've got to fix it. Knowing where to start will win half the battle.

Have you added any new equipment to the computer lately? Add-on cards, RAM extensions, modems and mice, as well as other peripheral equipment, may require that you change your computer's hardware and/

or software configuration. For example, the computer was working fine yesterday, but you've added a new serial card today. Now the computer won't boot up. Suspecting the addition of the new serial card is an excellent place to begin your troubleshooting operation. It's possible that the new serial card is currently configured to use the same port address as a card that was already installed on your computer. More about address conflicts later.

Or did DOS display a cryptic error message such as Sector Not Found? PC Upgrade can help you identify and correct such errors.

We will look at hard drives, power supplies, monitors, floppy drives, and modem cards. For hard drives we will begin by looking at software utilities that can identify and repair damaged portions of the hard drive.

Utilities

For correcting logical or physical disk problems, disk repair utilities offer quick and easy solutions. Two disk utilities stand out: Norton Utilities and Mace Utilities. These tools come in handy when you receive error messages concerning hard drive failures, missing hard drive controller messages or messages indicating missing or corrupt files.

Norton Utilities v6.01

Norton Utilities offers simple and intuitive menus that quickly guide you through the troubleshooting process. A menu option called Advise will list common DOS error messages, give appropriate suggestions, and even offer to run the correct utility for you.

The utilities cover three basic ar-

eas: Data Recovery & Repair, Performance Enhancement, and Security. The data recovery section allows you to undelete files, unformat disks, and even repair damaged 1-2-3 and Dbase files.

The Disk Doctor repairs common disk problems such as bad sectors, and cross-linked files. The user interface of Disk Doctor walks you through a series of simple questions and always prompts you before making any changes to your disk. If a change might cause any problems, an undo file can be created to reverse the procedure.

Hard drive performance can be increased by using the Speed Disk de-fragmenter, or the Ncache disk caching program. To optimize the disk interleave, the Calibrate program will test your drive at different interleave settings. The interleave can then be changed without destroying any data, but only for non-IDE drives. IDE drives are pre-set and low-level formatted at the factory. Unfortunately, you cannot adjust the interleave on an IDE drive. (For more on changing the interleave on the hard disk see "Breathing New Life into Old Storage Devices, p00.)

The System Information program works well for testing the CPU and Hard Disk performance. It combines the two ratings to give you an overall performance index. It also provides information about the computers CMOS settings, memory usage, and hardware/software interrupts. The Disk Monitor will watch your hard disk for unauthorized or dangerous writes that may damage it.

Norton Utilities provides excellent programs to aid the novice troubleshooter. Even if your hardware is working fine, the maintenance capabilities will ensure that it stays fine.

Mace Utilities 1990

Mace Utilities 1990 is available for

those who go where angels fear to tread, the deep dark disk sectors. While Norton Utilities offers a more intuitive interface for the non-expert, Mace Utilities does just the opposite. It offers trimmed-down, expert-level, flexible utilities. Mace concentrates more on data recovery, offering utilities to fix damaged files and a full-featured sector editor.



Even if you've spilled cherry Kool-Aid all over your disk it can be salvaged. Slice open one end, remove the media and wash it in warm water. Let it air dry and put it back in a new slip case.

Mace can recover accidentally formatted hard disks, or deleted files. It uses a top line menu system that allows you to choose from the various diagnostic programs organized under main groups. The groups are Performance, Info/Edit, Solutions, Format, Protection, and DOS.

When troubleshooting a hard disk, the Solutions group will allow you to test or repair both the disk and individual files. You can un-erase files through the Solutions group with the Undelete program. An accidentally formatted hard disk can be repaired with the unformat program.

For detailed sector editing for ex-

pert users, the Info/Edit group offers a utility called MUSE. MUSE is the powerful sector editor which allows byte-by-byte editing of disks. Due to the potential damage you can cause with MUSE, it has been likened to dabbling in genetic research. It is best used by experts who understand the details of sector editing a DOS disk.

The Performance group will allow you to de-fragment a disk, sort directories, move files between directories, and conduct other performance enhancements. Mace also has utilities for fixing damaged database and word processor files. For quick data recovery, Mace utilities works very well.

Reviving a dead hard drive

A hard drive error can occur for a variety of reasons. Telltale warning signs of a hard drive failure include errors or long delays when booting the computer, loading files or executing programs; files or programs that don't load at all or noises coming from the hard drive.

For the most part, DOS will tell you where the problem is occurring. However, it still takes a small amount of detective work to locate the exact area at fault.

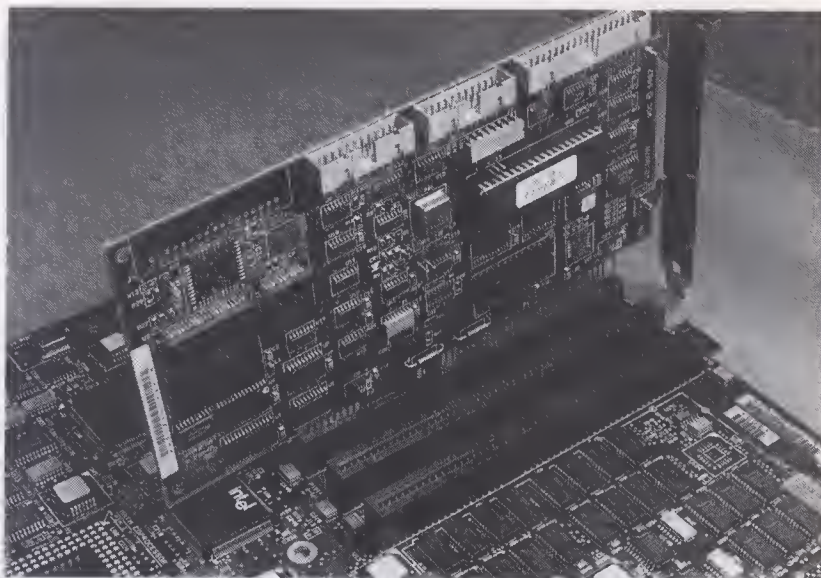
The most common causes of a dead hard drive are mechanical failures, controller cards, improper jumper settings or even a crashed hard drive. Another area to check into is electrical failures, loose power supply connections and the wrong wattage for the power supply.

Common mechanical problems

Loose Hard Drive Controller Cards

Hard drive controller cards allow the motherboard processors to talk with, and to move information to and from,

A loose hard drive controller card can look like something much worse. To fix it all you need is to push it back in!



your hard drive and floppy drives. Occasionally, these cards can become loose and pop out of their slot through transportation, improper installation, or vibrations.

To determine whether your hard drive controller card is loose, remove the casing from the computer by unscrewing the casing attachment screws and sliding the case off. Then look for a half- or full-sized card that has ribbon cables running to your hard drive, and in some cases to the floppy drives. A properly seated card will be tightly fitted in its slot and will appear level rising from the motherboard. Place your index finger and thumb along the top of the card and press down evenly on the card. If there is no give in the card, then it is probably resting in the slot properly. Another way to tell whether the card is seated properly is to examine the area where the card fits into the slot on the motherboard. Several vertical lines of copper appear at the cards base. If the card is resting in the slot correctly, you will see the same amount of copper appearing all along the cards base. If the amount of copper is uneven, the card is not fully seated in its slot.

Jumper Settings on the Hard Drive

You've just installed a new hard drive, connected the cables, and powered up. However, no light appeared from the hard drive, and the computer did not boot. This failure could indicate an improper jumper setting on the hard drive. Jumpers are small plastic blocks with two small holes, lined with metal for electrical contact. These blocks are placed over sets of metal pins. **IMPORTANT:** Write down or draw the current position of the jumpers before you change the settings.

The problem can be as simple as failure to run your CMOS setup routine in order to tell the system that you've added a hard drive and what type it is. See your manual for type.

Review the installation and configuration manual that accompanied your hard drive. If the settings appear correct to you, and you still do not have a functional hard drive, contact the dealer where you purchased the unit and query the technical support people about the jumper settings, or any other possible causes for the failure.

Drive Locked in the Parked Position, or a Frozen Stepper

You parked your hard drive before transporting the computer from one office to another, and now the hard drive will not boot or unpark. This failure can be a frozen stepper problem commonly associated with a parked hard drive.

If you have a friend who thinks he's very savvy about computers and tells you to gently shake the computer case up and down or gently tap on the top of the hard drive casing. **DO NOT FOLLOW THIS ADVICE.** When parked, the head is resting on an unused portion of the drive surface. By shaking it loose you can easily bounce it across the drive surface and permanently damage your hard drive. It's probably time to contact your local computer dealer and get some assistance.

Common electrical problems

Power Supply Connection

This problem is more common than anyone would like to admit. The power connectors for the hard drive can sometimes be very difficult to seat all the way into the power connection

receptacle. It may look like the power connectors are in, but if you give another push you may find that they did not click into place the first time.

Wrong Wattage

This problem is common for users who have upgraded from an XT to an AT computer, or even an AT to a high-speed 386.

You've installed a new motherboard, but neglected to ensure that your power supply is adequate to support the new speed RAM chips, or the power requirements for the new board. The power supplies that are normally recommended for XT, AT, 386 and 486 computers breakdown like this:

System	Recommended Power Supply
XT	150 Watts
AT	200 Watts
386	220 Watts
486	230 Watts

Monitors

Several problems can occur with monitors, usually relating to the quality of the video being displayed, even the lack of video.

No Picture

If no video is displayed when you turn on the monitor, the video card may be installed improperly, or the video cables may be loose or incorrectly connected. The steps below can help you identify and correct the error.

Step 1. Make sure the video card is seated properly in its slot. Some motherboards may beep at you if no video card is detected.

Step 2. Make sure the XT/AT video switch is in the proper position. (Check your motherboard manual for the switch location and positions for CGA/EGA video or color ON/OFF switch.) Usually switches 5 and 6.

Step 3. Wiggle the video cable at the back of the monitor and at the back of the computer to ensure a tight connection.

Bending Images at the Edges of the Monitor

If the video is bending at the edges of the monitor, a capacitor in the monitor probably is beginning to fail. Unfortunately, unless you happen to be a TV repairman as well as a computer whiz, you'll have to take the monitor in for servicing to repair/replace the failing part.

Flashing Image, Loss of Color, or a Color Band on the Display

This failure is almost always attributable to a loose video cable. Wiggle the video cable at the back of the monitor and at the back of the computer to ensure a tight connection.

Popping Noises

Popping noises coming for your monitor are a very bad sign. Turn off the monitor immediately, and do not attempt to turn it on again. This kind of failure indicates the high-voltage section within the monitor is about to go. This can lead to a complete loss of the picture tube, or even a fire.

Bad Colors

A change in the usual colors displayed on your monitor can indicate that one of the three color guns in the unit has failed. This kind of failure requires that the monitor be taken in for servicing. However, the color change may also be due to loose connections between the video card and the monitor.

RF Noises

Occasionally, a monitor gives off excessive RF noise. This noise can interfere with TV and radio reception within a short radius of the monitor (usually within 30 feet). The noise can be caused by loose components within the monitor, or a failing component. Either way, the monitor should be taken in for service.

Floppy drives

A lost cluster sounds like a catastrophic error, as do the regular DOS error messages. A few of the most common errors associated with floppy drives are detailed below.

Sector Not Found

This DOS error indicates that a sector on your floppy or hard drive was not located. This error can be caused by a corrupt file, or damage to the floppy or hard drive. Use the CHKDSK /f command at the DOS prompt to locate and retrieve any data stored within these damaged sectors. You may also use Norton Disk Doctor to find, identify, and repair any damaged sectors.

Data Error Reading Drive A:, B:, C:, etc.

This DOS error may indicate that a damaged disk is located at the appropriate drive letter or if an unformatted disk is detected, or a disk formatted on an incompatible drive type.

Unfortunately, this message can also occur if your floppy drive has gone south! Floppy drives can easily get out of alignment in which case it may only read floppies formatted on that particular drive. Or worse still, the drive itself or the controller card may be damaged. If the controller card is also running your hard disk this is unlikely. But a floppy drive also has a great deal of circuitry that can burn out.

Erased or Over-written Files

This DOS error indicates that two files are conflicting in the FAT table, and that an overwrite has occurred.

Bad or Missing Command Interpreter

This DOS error indicates that the COMMAND.COM file is corrupt, or even missing. To replace this file, we recommend that you recopy the COMMAND.COM from your original DOS boot disk, type SYS plus the drive letter or reformat the floppy drive using the FORMAT A: /s com-

mand, or use Norton Disk Tools. If this error occurs on the hard drive, you may have to reformat the hard drive. This need not be a fatal situation, however, since you can boot the computer from a floppy drive and copy necessary files off the hard drive to another floppy before reformatting the hard drive.

Lost Clusters and Allocation Files

This DOS error indicates that a cluster of data, usually several sectors, has been damaged or is corrupt in the FAT (File Access Table) Table. This table keeps track of the location of all of the files on your hard drive and what sectors or clusters the files use. Use the CHKDSK /f command at the DOS prompt to locate and retrieve any data stored within these damaged clusters. You may also use Norton Disk Doctor to find, identify, and repair any damaged clusters.

Disaster disks

There is always a chance that your morning cup of coffee will wind up on the disk that contains your only copy of that special report that big 200-page report that took you months to complete. Or the disk might have fallen to the floor to be embossed by the rollers on your chair.

In cases like this, where the disk is physically damaged, the chances of recovering the data are very slim. When reading a damaged disk, you may receive an Abort, Retry, or Fail message. When you get this message, you might try the Retry option several times. Often the disk drive will get a good read after a few attempts.

If the disk has had liquid spilled on it, you might try the following steps:

Step 1. Carefully pry open the disk jacket of the bad disk and remove the mylar floppy disk. Try not to touch the data surface of the disk. Hold it by the center opening.

Step 2. Next, use a sink and care-

fully rinse off the liquid stains, being careful not to rub the surface. Make sure the water is room temperature. Very hot or cold water may damage the disk even more.

Step 3. After cleaning the mylar, pat the disk dry with something soft and absorbent. Again try not to rub the surface.

Step 4. Now choose a good sacrificial disk, and cut the top edge of its jacket. Slide out the good mylar and slide in your cleaned disk. If the disk has a reinforced center ring, use it to determine the top side of the mylar disk. If not, you may have to try it both ways to make sure it is in right side up.

Step 5. Attempt to access this repaired disk in your PC.

If the disk was bent, you might try removing the mylar as mentioned above, and carefully crease the bend in the opposite direction to straighten it out. Replace the mylar in a new cover and try reading the disk again.

With any of these disaster disk techniques, the odds are against you. But if the data is very valuable, you could come out the big winner.

There are also many data recovery services available. See the Market Place section of many computer magazines. At the end of this article we list the name, address and phone number for Backup Support Services one such organization.

Modems or other external peripherals

One of the most frequent complaints about modem and other peripherals installation has to do with conflicting addresses.

These addresses are sometimes known as COM port locations or IRQ (Interrupt ReQuest) addresses. They allow the computer to communicate through the different ports and addresses to your peripherals.

When you install a modem card,

you will be asked to specify the COM address at which the modem is to reside. Conflicts can occur if you have several peripheral cards installed already. To avoid these conflicts, consult your individual information cards about each peripheral prior to installing the modem card. Common peripherals which assume a COM port include serial mice, external modems, internal modems, FAX cards, scanners, etc. If a conflict still occurs, or other peripherals are affected do the following:

1. Check to see which peripheral was affected and which COM address it was configured for. You can usually change the COM address a peripheral board uses by changing the jumpers on the board. See the manual for details.
2. Check the jumper plugs on each card to ensure the correct COM address is being specified. This is where 90% of your conflicts can be found.
3. Check the IRQ1 through IRQ4 settings to determine which COM ports are allowed.
4. Check the communications software to see if it is set for the right communications port.

Products Featured

Norton Utilities v6.01

Price: \$179.00

Symantec/Peter Norton Computing Group

2500 Broadway, Suite 200

Santa Monica, CA 90404

Telephone: (800) 441-7234

(310) 453-4600

Mace Utilities 1990

Price: \$149

Fifth Generation Systems, Inc.

10049 North Reiger Road

Baton Rouge, LA 70809

Telephone (800) 873-4384

(504) 291-7221

Portable Storage Devices

Adaptability must be a part of the very nature of the concept of a movable storage device. Here are four devices, each unique, one of which just might meet your exact needs.

The notebook revolution produced a new class of machines: those in which power was no longer a trade-off for portability. It's perfectly possible today to carry a portable computer that's as powerful as—or even more so than—its desktop counterpart.

But one aspect of desktop computing still can't keep up with you on the road: mass storage capacity. Hard disks larger than 80Mb or so just aren't found on many notebooks, and the few available are costly. And as more and more people rely on portables as their only computers, a new sort of configuration has appeared: Users are setting up workstations at both ends of their commutes, with desktop monitors, printers, and other peripherals into which the portable computers can be plugged. As those setups have proliferated, portable disk storage devices have appeared.

As has been the case with most new portable computer equipment, the vari-

ous disk storage devices appearing on the market don't bear much similarity to each other. (New classes of products seem to encompass a group of dissimilar items. The design of one popular model eventually emerges as the standard shape and configuration—just as the notebook computer design won out over a group of others that look mighty peculiar today.)

Each of the products reviewed here exemplifies its maker's vision of what portable data storage should be. Most take the form (more or less) of an external box that plugs into your computer's parallel port. Others attach to a Small Computer System Interface (SCSI) card that fits inside your portable PC. Some are actual hard disks, external plug-in versions of the device inside almost every desktop PC. Most of these are attached at your computer's parallel port with an ordinary printer cable. Others are more like floppy disk drives, with removable disks that look

like floppies but hold many times more data. Some products, such as the Bernoulli Transportable, are large and durable; others are far smaller and less obtrusive. Some are amazingly fast, especially when aided by a SCSI adapter. Others, like the GrassRoots 2020e, are only a step faster than a standard floppy disk drive but are extremely affordable.

What should you look for when shopping for one of these devices? Obviously, disk capacity should be near the top of your list of criteria. If you need to store monster files from a color desktop publishing program, don't expect to get a good-sized hard disk and call it a day. Those who create huge files often and need to save them constantly should look for a drive with removable disks—in effect, to save everything on floppies, albeit far fewer of them than would be needed otherwise. If your data storage needs are more modest—typical word processing requirements,

for example—a portable hard disk may be just right, and won't have you shelling out hundreds of dollars for those high-priced, super-duper-capacity floppy disks. (A three-pack of 90Mb Bernoulli disks, for example, lists for \$687, or about \$2.50 per megabyte; for comparison, traditional floppies go for about \$1.20 to \$1.50 per megabyte—at the typical discount—these days.) Removable media are also important if you're worried about security: you can pop them into a hiding place (a safe, if you're worried about fire) if need be, or carry them on your person if you're really paranoid.

Product performance aside, each vendor provides different ways to work with its product. Some require you to use down-to-earth DOS commands to prepare the storage device; others provide elaborate installation software. Some require no installation software at all. The prices of these products can vary as well, from \$595 to over \$1,400. Likewise, the prices of the storage media vary as well.

REVIEWS

Iomega Bernoulli Transportable 90

At \$1,149, the Bernoulli Transportable from Iomega is the most expensive product we reviewed. But it's also the only one that offers high-speed, removable storage. Each Bernoulli disk—resembling an oversized 3.5-inch floppy disk—can hold 90Mb of data.

Bernoulli drives are named after Daniel Bernoulli, an 18th-century Swiss mathematician. Bernoulli formulated a principle of aerodynamics that, among other things, makes it possible for a spinning flexible disk to remain at a precisely controlled distance from a read/write head. The gap between the two can be maintained very precisely, allowing consistently reliable storage.

The Bernoulli Transportable can work with your computer two ways: through the parallel printer port (like

most of the other products reviewed) or through an interface card installed in your computer. Whichever method you select, plan on spending an extra \$265 for the interface kit, putting the price of the Bernoulli Transportable at over \$1,400.

In some ways, the device itself looks like an oversized removable car radio. A pull-out handle lets you carry the Transportable to your destination. As with the other products, installation was easy: Just attach a cable from the rear port of the Bernoulli Transportable to your computer's parallel printer port.

After attaching and turning on the drive, we had to install the software. The installation software comes on a 3.5-inch disk, which can be exchanged for a 5.25-inch version by calling Iomega's toll-free customer service number. (All the other products we reviewed provide installation software in both sizes.) The Bernoulli Transportable requires an operating system that supports partitions larger than 32Mb, usually MS-DOS 4.x or greater and some vendors' special editions of DOS 3.3. (Central Point Software *Backup* is also included.)

The installation software was adequate but unglamorous. A simple batch file called other programs. Despite online Help and the documentation, we weren't sure about certain of the settings: for example, Iomega recommends that DOS's VERIFY feature be added to your AUTOEXEC.BAT, but then has you set the default to "NO," disabling the feature.

Like most of the other products, the Bernoulli Transportable requires a driver to recognize the storage device. The installation software adds RCD.SYS to your CONFIG.SYS file. This driver requires 13.1K in memory, more than any of the other drivers we saw. It can, however, be loaded into upper memory.

Next, we had to format the Bernoulli disk with the special utility Iomega provides. (Don't use the FORMAT command.) You can also use the RCD

software to create a mirror-image copy of a Bernoulli disk. We formatted a

Product Overview

Product: Bernoulli Transportable 90

Maker: Iomega Inc.

Retail price: \$1149 (drive only)

Includes: Bernoulli Transportable, DB25 cable, 5.25-inch installation software, power cord, vertical stand, one 90MB Bernoulli disk and Central Point Backup software.

Required: parallel printer port Interface Kit (\$265), or IBM PC/AT or MCA Interface Kit (\$265 and \$399, respectively).

Options: Tri-Pak of 90MB 5.25-inch Bernoulli disks (\$687)

Phone: 800-777-6179

Compatibility: PC/XT/AT/386/486, PS/1, PS/2

Requires: DOS 4.x or greater or any vendor's DOS that supports partitions beyond 32MB.

90Mb disk in just under 14 minutes.

The Bernoulli Transportable has thorough and attractive documentation. It covered all the various models of the Bernoulli storage systems, however, and sometimes stumbled over itself as it cross-referenced you to other chapters and manuals. We started with the "Subsystem Installation Guide" and then shifted over to the "Iomega Host Adapter Installation Guide." A "Parallel Port Host Adapter Quick Reference Card" fell out of that manual and helped us connect the Transportable to our test system. We then had to refer to the

"Iomega Drivers for DOS" manual to set up the software.

The Bernoulli Transportable is a quiet drive. We found its performance to be comparable to its hard disk competitors. When the disk release button is pressed, the drive spins down to a stop and the removable disk is unlocked. When the Bernoulli Transportable is connected via the parallel printer port, two Bernoulli Transportables can be daisy-chained. (Given that the cartridge is removable, however, why would you need two?)

We also tested the Bernoulli Transportable with its other interface kit, the PC2B Host Adapter Board. The optional interface card for the IBM PC/AT sells for \$265. The Micro Channel version, for the PS/2 and its clones, is priced at \$399. The card takes an 8-bit expansion slot and connects to the Transportable with a thick, shielded cable. Using the Host Adapter Board, the Transportable was about twice as fast as when using the parallel printer cable. It was as fast (if not faster) than our test system's own 13-millisecond hard disk.

Unlike the other products, the Bernoulli Transportable cannot share the printer port with your printer. You can, however, buy a parallel printer port multiplexer from Xircom (\$95), splitting your single parallel printer port into two. An A-B switch box won't work.

Bernoulli boasts that the Transportable can withstand an eight-foot drop (about 1000G). We ran in informal four-foot drop test (guess how) without producing a noticeable effect on the device. It's rated a FCC Class B device, sound for both office and home use—the only product in this review that met the more stringent Class B radio interference standards.

Minimal maintenance is required. All Bernoulli drives shipped after July 1991 have an automatic head cleaning system. The air filter outside the cooling fan should be replaced every six months or when it's dirty.

Iomega provides technical support

by voice, CompuServe, AppleLink, and the company's own 24-hour electronic bulletin board system. Iomega is the only company in this roundup that provides toll-free phone support. The phones have a sophisticated menu and queueing system, even telling us how long we had been on hold.

Technical support is provided Monday through Thursday from 7 A.M. to 5 P.M., and Friday from 7 A.M. to 3 P.M. (Mountain Standard Time). We had a legitimate question to ask Iomega technicians: We couldn't create more than one partition on a Bernoulli disk. Every time we attempted to create a second partition, the software instructed us to delete the first.

After two minutes, a technician came on the line with a solution: He said the Transportable did not support more than one partition. (The software offers the choice for multiple partitions because it must work with several Iomega products.)

Iomega provides a one-year warranty covering materials and workmanship. The "Gold Standard" 5.25-inch disks have a five-year warranty.

If you require roomy removable storage that is also portable (and durable), the Bernoulli Transportable fills the bill. Although each 90Mb disk costs over \$200, the Transportable is a versatile tool for backing up several computers and storing the critical information off-site.

Company: Iomega Corporation, 1821 West 4000 South, Roy, UT 84067, (800) 456-5522, (801) 778-3000.

GrassRoots 2020e

The GrassRoots 2020e is a unique product: its special 3.5-inch removable disks hold 20Mb of information, and the device doubles as a conventional disk drive for smaller-capacity 720K and 1.44MB diskettes. The drive itself is an external device that connects to your computer through a SCSI (Small Computer Systems Interface) host adapter

card. An internal model (the 2020i) is also available. Both products became widely available in January.

Priced at an affordable \$595, the GrassRoots 2020e package includes everything required: the external drive, a SCSI host adapter, utility disk, ribbon cable, power cord, and one 20Mb diskette. The product works best with AMI, Phoenix, and Award BIOSes, and MS-DOS version 3.3 or later. No head-cleaning is needed for the GrassRoots 2020e, and the drive can handle a shock of 60Gs.

A proprietary BIOS allows the GrassRoots 2020e to operate without having to install memory-grabbing device drivers. It was the only product of those reviewed that didn't require any memory. Also, the GrassRoots 2020 can be your boot drive even if it isn't labeled drive A or C.

The GrassRoots 2020e wasn't the fastest storage device we saw, since it's a floppy disk drive at heart. However, the transfer rate was more than triple that of a conventional floppy disk drive.

The 2020e's SCSI host adapter requires an awkward two slots: one for the 8-bit host adapter circuitry and the second for the external cable connector. The idea seems to be that a buyer of the internal drive won't have to add another 8-bit board. However, some users may not have that extra slot available. Once it's installed, the host adapter is attached to the external disk drive by a three-foot shielded cable. We started our test system, and the proprietary BIOS recognized the 2020e immediately.

The utilities needed to use the GrassRoots 2020e were hiding in one of three directories on the software disk. It appears the diskette is also used by customers who buy the SCSI host adapter for use with other removable storage devices.

The two main utilities for the GrassRoots 2020e are QFMT, used in lieu of DOS's FORMAT to format the 20Mb diskettes, and LFMT, used to low-level format the disk. (LFMT shouldn't be needed, since the dis-

kettes are pre-initialized.) You can still use DOS FORMAT for 720K and 1.44Mb disks.

The documentation wasn't very helpful when it came to installing the drive. The 20-page manual was full of the technical specifications of the product but didn't give much information about how to install it. Only in the appendix were there diagrams—but they didn't apply to the product reviewed. We contacted GrassRoots's technical support, which is open weekdays from 8 A.M. to 5 P.M., Central Standard Time. The small company provided personable and knowledgeable support.

The company provides a 90-day warranty for the BIOS and formatting software, although the drive and accompanying hardware are warranted for one year. At the company's option, GrassRoots will refund your money or repair or replace your software or hardware.

For under \$600, the GrassRoots 2020e provides the removable storage of a small hard disk. In some ways the GrassRoots 2020e is like a poor man's Bernoulli Transportable; it's certainly not as fast, but for \$25 per 20Mb disk, you can back up your materials affordably and easily without device drivers.

Price: \$595; 20Mb Floptical diskettes, \$25 each.

Company: GrassRoots, 8230 Nieman Rd., Lenexa, KS 66214, (913) 681-3001.

Sysgen Mobile Disk 80

The Sysgen Mobile Disk, introduced last November, competes closely with the Data Traveler from Kingston Technology. Both products provide portable hard disk storage through your computer's printer port. Sysgen, however, may have done so with the most elegance.

We tested the 84Mb version of the Mobile Disk, which retails for \$795. The Mobile Disk 120 provides 120Mb of storage for \$895; the 42Mb Mobile

Disk 40 costs \$550.

The Mobile Disk occupies a sleek-looking molded plastic case designed to withstand 75G. The Mobile Disk is substantially smaller than the Data Traveler. It's about the size of a pair of VHS videocassettes—50 percent smaller than its competitor.

Product Overview

Product: Mobile Disk 80

Maker: Sysgen Inc.

Retail price: \$795

Includes: Mobile Disk drive, DB25 cable, 3.5- and 5.25-inch installation software and transformer.

Phone: 408-263-4411

Fax: 408-263-2727

Compatibility: PC/XT/AT/386/486, PS/1, PS/2

Requires: DOS 3.0 or greater

The Mobile Disk holds a Conner or Quantum IDE drive with a speed of 28ms or less. On the back of the device is a port to connect your printer. A green light on the front indicates when the disk is being accessed. There is no power indicator light—but that may not be a problem, since the Mobile Disk, unlike the Data Traveler, doesn't have to be on to allow printer throughput.

The Mobile Disk driver software comes on both low-density 3.5- and 5.25-inch floppy disks. The device driver, MOBILE.SYS, requires only 7.8K of memory and can be loaded into upper memory. Besides the software and drive, a power cord and a parallel printer cable are included with the kit. Installing the Mobile Disk was similar to installing the Data Traveler. The

parallel cable is connected between your computer and the rear of the product. Your printer then connects to the back of the Mobile Disk, at the second port.

The Sysgen Mobile Disk had the clearest documentation of the products reviewed. In 20 pages, it clearly discusses how to set up and use the drive. What was most impressive was the all-in-one Mobile Disk utility, MOBILE.EXE. This utility creates a directory for the Sysgen software, modifies CONFIG.SYS, offers default names and sizes for partitions, and displays a READ.ME file of last-minute changes and exceptions—in short, it automates all the nasty details of configuration, and formats your disk when it's done.

After the installation procedure is done, you may use the Mobile Disk utility to change the size and number of partitions quickly and easily. (Don't save anything first, however—you'll lose your data.) A menu choice even lets you remove the Mobile Disk software, returning your computer to its original state. (You still have to remove the empty directory, however.)

The installation software loaded the device driver into low memory, but a quick editing of CONFIG.SYS moved it to DOS 5.0's upper memory. Another minor complaint is that we were initially unsure which choice was highlighted because of the color combinations used in the software. Still, the installation software is a boon for both new and experienced users.

The Mobile Disk occupies half the volume of the Data Traveler, and at 2 pounds, it weighs a third less. However, these figures may be misleading since you also have to carry the Mobile Disk's special power unit, which has the biggest transformer we have ever seen. (That transformer weighs more than one pound.) The Data Traveler, on the other hand, requires only a simple power cord.

LIGHTER OR HEAVIER?

A green light indicates the operation of

the Mobile Disk. In use, the product was substantially noisier than the Data Traveler, reminding us of an old XT drive. However, if the extra noise is the result of its smaller housing, then the Mobile Disk may be allowed its extra noise. The speed of the Mobile Disk seemed a little slower than the Data Traveler.

The Mobile Disk did not have to be on to print. In fact, the Mobile Disk driver does not load if the drive is not on. However, the printer attached to the Mobile Disk may need to be on for the drive to work. Sysgen has found this to be the case for some Hewlett-Packard LaserJet and DeskJet printers. If you decide you need additional external storage, up to four Mobile Disk drives can be daisy chained together.

If the Mobile Disk has not been used for 18 minutes, it automatically stops its drive from spinning. When needed again, it may require up to 20 seconds to get "up to speed." We found the delay to be only a few seconds and certainly negligible. The Mobile Disk is a FCC Class A device for commercial use.

NO TECHNICAL PROBLEMS

Sysgen provides a one-year warranty that covers defective material and workmanship. The warranty includes parts and labor, and all returns are sent directly to Sysgen. Technical support comes in two forms: by phone and through electronic bulletin board. Technical support is provided between 8 A.M. and 5 P.M. (Pacific Time). We called technical support and, after a scratchy recording, waited for 10 minutes to receive assistance. To leave a message, customers must call a second number. Fortunately, we had no actual technical problems and believe users would likely not have any installation problems with the Mobile Disk.

The Mobile Disk provides the simplest and easiest storage for novices, and its elegant installation software may be a welcomed sight for advanced users.

Kingston Technology Data Traveler (105MB)

The Data Traveler, introduced by Kingston Technology in April, provides portable hard disk storage through your computer's parallel printer port. Whether your current computer has one disk drive, two disk drives or a hard and floppy disk drive, the Data Traveler can supply extra needed storage.

The Data Traveler is ideal for laptop computer users. Since laptop computers have little or no hard disk storage and no room for hard disk controller cards, the Data Traveler is an excellent candidate since it uses the printer port. The Data Traveler can also be used for moving large amounts of data between computers.

We tested the 105MB version of the Data Traveler, which lists for \$1095. However, other sizes are available: 52MB (\$795), 84MB (\$895) and 240MB (\$1995).

QUALITY OF CONSTRUCTION

The Data Traveler is housed in a sturdy metal housing designed to withstand a 70G drop. The beige box has the same dimensions of a large computer book and weighs in at 3 pounds. At 2 inches high, it should fit most briefcases.

The heart of the Data Traveler is a Quantum IDE (integrated drive electronics) hard drive powered by a 30-watt power supply. Even though the Data Traveler uses your parallel printer port, a printer port on the back of the Data Traveler still lets you connect your printer. One caveat: the Data Traveler needs to be turned on for you to print.

The Data Traveler is a FCC Class A device, making it best suited for commercial but not residential use. The Data Traveler comes with everything you need to use it: drive, a simple power cord and a special DB25 printer cable.

The software driver required for the Data Traveler (KTCDDT.SYS) comes on both low-density 3.5- and 5.25-inch sizes. This device driver requires only

6.7K of memory and can be loaded into upper memory if you have DOS 5.0 and an 80386 or 80486 computer.

INSTALLATION IS A SHORT TRIP

Installing the Data Traveler is quite simple. First, we connected the Data Traveler's special parallel printer cable to our computer. Next, we plugged our existing parallel printer cable into the back of the Data Traveler. We copied the Data Traveler device driver (KTCDDT.SYS) from the included Kingston diskette to our directory and modified our CONFIG.SYS startup file to load it.

We rebooted our computer to load KTCDDT.SYS and activate the Data Traveler. Using FDISK, we prepared the Data Traveler for use with DOS. Although we could have broken the Data Traveler into eight partitions (drives D through K), we opted for only one. After saving our partition information and rebooting the computer again, we used FORMAT to prepare the new partition. Kingston Technology could have automated this process with installation software, but decided to let customers use the conventional DOS commands themselves.

A BETTER ROAD MAP NEEDED

The documentation throughout installation was, at first glance, unimposing. A 12-page manual helped us get the Data Traveler up and running. However, the manual poses some pitfalls for less advanced users.

For example, we had difficulty using FDISK on the Data Traveler. After manually adding the line to load KTCDDT.SYS in our CONFIG.SYS file, we were instructed to use FDISK to have DOS recognize the Data Traveler. The manual implies starting your computer from a bootable diskette in drive A. Unfortunately, you cannot partition the Data Traveler unless KTCDDT.SYS is loaded. We instead ran FDISK after booting from our hard disk and then formatted the disk.

(continued on page 91)

Backing It Up

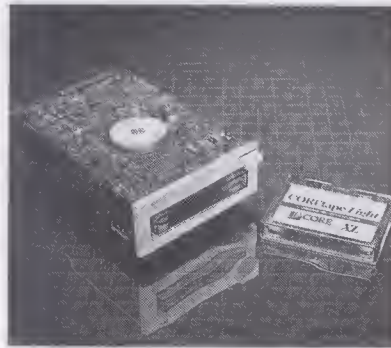
Imagine a pile of dishes stacked too high and sitting on the edge of a table. Imagine someone bumping into that table. Now imagine the data stored on your hard disk as those dishes. Tape backup offers the kind of cushion you need to minimize the inevitable crash.

Core International COREtape Light

As 100Mb and 200Mb hard disks become common, it's hard to argue against installing a tape drive to back up such large amounts of data. Core International's COREtape Light is a good choice for users with hard disk capacities up to several hundred megabytes who are looking for an affordable, easy-to-use tape backup method.

Like all the other units reviewed in this section, the COREtape Light uses a quarter-inch DC2000-style cartridge. With the included data compression, the cartridges have a capacity of 300Mb. Core offers internal and external models for PC compatibles and Micro Channel Architecture (MCA)-based computers. We reviewed the external model for PC-compatibles and tested the drive with a 40-MHz 386-based computer.

Prices are \$570 for the external PC-compatible drive, \$350 for the internal PC-compatible drive, \$610



for the external MCA-based drive, and \$350 for the internal MCA-based drive. Included with each drive is a controller board, cables, Y-splitter power cable, and backup software. Core sells cartridges in boxes of five for \$225. Core tells us that actual street prices are as much as 50 percent lower than these suggested retail prices, making a drive available for about \$300 or less.

Installing the drive is fairly simple, and the documentation breaks the

steps down in a logical, informative manner. The 8-bit controller board slides into any 8- or 16-bit expansion slot. The floppy drive cable connects to this board, and one of the cables included with the tape drive connects the tape's controller board with the floppy drive controller board. Connect the included Y-splitter power cable that lets you tap into any of the system's power supply connectors, and you're done. With the board and cables in place, you can slide the cover back on and connect the drive to the board's port.

To install the backup software, simply type INSTALL, and the program will create a subdirectory for the files and include the subdirectory in the path command of the AUTOEXEC.BAT file (if you want). During installation you can also decide to install a basic or advanced menu interface. Both interfaces offer on-line help, file-by-file backup and

restore, and utility functions including formatting and retensioning the tape. The advanced interface adds a variety of other functions, including mirror-image backup, sorting files by size, creating directories, and setting predefined backup operations.

Both interfaces are organized in the same way, and both use function keys to initiate most of the commands. The commands are consistent throughout the different options within each interface, which speeds learning of the backup software. So, for example, F10 starts the backup procedure for file-by-file and mirror backups in the basic and advanced interfaces.

You can also initiate all COREtape features by typing commands at the DOS prompt. This is a much more time-consuming and confusing method than using the COREtape interface when you first start using

COREtape. If you take the time to learn these commands, however, they can actually save you time since you won't have to enter the COREtape software.

As with most backup software, you can select backups to occur even when you're not there. The only requirement is that the system be on and at the DOS prompt, and the drive ready with a tape installed. The software also has a handy feature that beeps a tune if a backup has been set to occur at a time when you're working in an application.

The drive's rated transfer rate for backing up data is 500K-bits per second. The actual speed varies, however, depending on whether you use data compression. Full or partial compression can be selected from the backup software, offering a maximum tape capacity of 300Mb. The reviewed drive performed a file-by-

file backup of approximately 27Mb of data scattered across a variety of different directories in 12 minutes and 25 seconds without data compression, 9 minutes and 8 seconds with partial compression, and 11 minutes and 8 seconds with full compression.

The COREtape comes with an 18-month warranty on parts and labor. Core has technical support lines available from 8 A.M. to 6 P.M. Eastern Standard Time weekdays and 8 A.M. to noon on Saturdays. The support is free but the call is not.

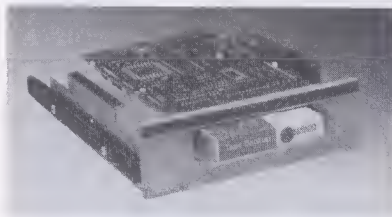
The COREtape is simple to install and operate, yet it offers a full set of features. The speed is adequate and the ability to set a backup to occur in the middle of the night eliminates the speed issue completely. With so much vital data on your hard disk, it is hard to argue against investing in a COREtape Light.

Capacity: 300Mb with compression. **Price:** External PC-compatible drive, \$570; internal PC-compatible drive, \$350; external MCA-based drive, \$610; internal MCA-based drive, \$350. **Company:** Core International, 7171 North Federal Hwy., Boca Raton, FL 33487, (407) 997-6055.

Colorado Memory Systems Jumbo 250

Order a computer with a tape backup drive and, more likely than not, the manufacturer will use the Jumbo 250, a 250Mb tape drive from Colorado Memory Systems that uses quarter-inch DC-2000-style cartridges. Manufacturers like the Jumbo for its reliability, relatively fast backup speed, and low price, and computer users will like the Jumbo for those same reasons.

The drive's Jumbo name could refer to the number of drive kits and options CMS offers, which cover 14 pages in an included compatibility and accessory guide. This guide also lists compatibility with individual models for 82 computer manufactur-



ers. Sometimes such comprehensive information is nothing more than overkill, but here it serves its purpose: to let the user select the kit that is best for his needs.

The Jumbo is available in internal and external models for PC-compatibles and MCA computers. The drive for all models costs \$350, with additional costs for the drive kits

required with the external models. We reviewed the external model for PC-compatibles, and the kit for this model costs \$160. The kit for the external MCA model costs \$177.95. Included with all kits is everything needed to set up the drive.

The external unit requires more assembly than external drives from some other manufacturers. CMS ships the external case, which includes a cooling fan and the needed cables, and the drive, but the user has to install the drive inside the case. The process is simple, however, and anyone who's comfortable installing boards and drives inside a computer shouldn't have a problem.

An automated program simplifies the installation of the backup software. The installation process takes a couple of minutes and users have to answer only a few questions about their hardware along the way. The software uses function keys to select and initiate the type of backup or restore operation wanted. Commands are clearly described on screen and the use of the function keys is standard throughout the program. All in all, using the software is easy from the first day and only becomes more so as you begin to know all the function key commands by heart.

The software enables you to perform an unattended backup at a later date or back up immediately individual files, all files, or only those files modified since the last backup procedure. These choices are standard among backup software. You

can also link tapes, enabling you to back up hard disks larger than the capacity of a single Jumbo tape by recording the data to as many as 255 tapes.

Backup times vary depending on the type of data compression you select. The backup software lets you select no compression or compression routines that compress data by approximately 40 or 50 percent. When backing up 27Mb of data from a 40-MHz 386-based computer, the process took 11 minutes and 54 seconds with no compression, 7 minutes and 56 seconds with 40 percent compression, and 8 minutes and 21 seconds with 50 percent compression.

CMS includes individual manuals for hardware and software installation. Each is written in a plain-spoken, informative tone that guides you through installation and use of the

hardware and software. There is a brief troubleshooting guide that isn't as detailed as the one found in the Tecmar MiniVAULT manual. It offers advice when the drive does not work or recognize the software, when there are many retries during backup or restore operations, or when an unattended backup does not work.

The Jumbo comes with a one-year warranty on parts and labor. CMS provides toll-free phone support weekdays from 7 A.M. to 6 P.M., Mountain Standard Time.

The Jumbo 250 software provides plenty of options regarding how and when you back up your files, but is easy to use. Hardware installation is also simple. These factors, along with the drive's reasonable price, make it a good choice for any individual user looking for a tape backup drive.

Capacity: 250Mb with data compression. **Price:** Drive, \$350; PC-compatible kit, \$160; MCA kit, \$177.95. **Company:** Colorado Memory Systems, 800 South Taft Ave., Loveland, CO 80537, (800) 845-7905.

Irwin AccuTrak A250E

The AccuTrak A250E from Irwin Magnetic Systems, a division of Maynard Electronics, is a tape drive that on the surface is much like other every other drive on the market. On closer inspection, the AccuTrak stands out from the crowd on several points, such as the inclusion of DOS and *Windows* backup software with every drive. Like the other drives in this section, the AccuTrak uses quarter-inch DC-2000-style cartridges.

The drive we tested was an external model for PC-compatibles, and included the necessary cables but no drive controller, which Irwin sells separately. The suggested retail price is \$599 for the drive and \$179 for the controller. Internal models have a suggested retail price of \$479 for PC



compatibles and \$549 for MCA computers. Irwin's external drive for MCA is also \$599, and an MCA drive controller is priced at \$279.

Hardware installation is a simple procedure: Place the included controller board in one of your computer's expansion slots and then connect the drive to the controller with the in-

cluded cable. The drive can draw power from the computer (if you tap into one of the computer's power supply connectors) or you can connect an optional power module (\$149) that connects to the AccuTrak drive.

The bundled backup software, called *EZTape*, comes in versions for DOS and *Windows*, a distinction unique to Irwin. Features are the same for both versions, and both offer help screens, but the two programs (obviously) look different. *Windows* fans will love being able to use the tape software within the graphical interface; the DOS version has a structure found in many applications. (Options are contained within a box and you make selections by moving to the chosen option with the arrow keys or

by typing the first letter of the option.) Help screens are available in both versions.

One thing we didn't like about the DOS version was that it doesn't indicate what percentage of files remain to be recorded as the backup progresses. The *EZTape* software also doesn't indicate how long the backup took after the process is finished.

DOS users can set up what Irwin calls parameter files—essentially macros that execute a specific backup or restore operation. You create parameter files from within *EZTape* and identify them with any file name up to eight characters long. Once that's done, you can run the parameter files from the DOS prompt. This is especially useful for operations that are complex but repetitive. If, for example, you want to back up all files that have a certain file extension and are located in three directories on two hard disks, you can set up a file to do

this and then execute the file from the DOS prompt to perform the backup.

Both the DOS and *Windows* versions of *EZTape* can run on a variety of networks, including Novell NetWare, AT&T StarLan, TOPS, 3Com 3+, and IBM PC LAN.

The DOS manual has an index, but the *Windows* manual (which is longer) doesn't—a troublesome oversight. In other respects, both manuals are excellent: They're both well written and thorough, and both have troubleshooting guides and sections listing error messages and remedies.

You can set AccuTrak to operate without data compression, or compression of 50 or 80 percent. It took 12 minutes and 30 seconds to back up approximately 27Mb of data with no compression, 12 minutes and 52 seconds with compression at 50 percent, and 12 minutes and 12 seconds with compression at 80 percent.

AccuTrak comes with a two-year

warranty on parts and labor, more than you'll find on many other tape drives.

In addition, Irwin promises to repair or replace all damaged drives still under warranty within 48 hours. Toll-free technical support lines are open from 8:30 A.M. to 8 P.M. Eastern Standard Time, Mondays through Fridays. There is also a 24-hour BBS service offering technical and general product information.

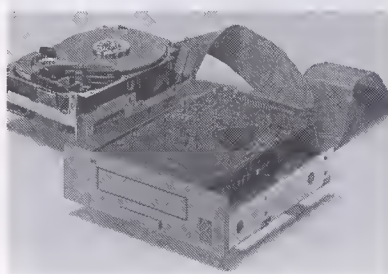
The AccuTrak shows a great deal of attention to detail and concern for what computer users want. With a *Windows* version of the backup software, for example, Irwin addresses the needs of the constantly growing population of *Windows* users without charging them extra for the software. The two-year warranty, generous tech support hours, and 48-hour repair policy for drives under warranty are further evidence that this is a drive built with the buyer in mind.

Capacity: 250Mb with compression. **Price:** \$599 for PC-compatible and MCA external drives; \$479 for PC-compatible internal drive; \$549 for MCA internal drive. **Company:** Maynard Electronics, 36 Skyline Dr., Lake Mary, FL 32746, (800) 821-8782, (407) 263-3500.

Mountain FileSafe 8500

Mountain Network Solutions has manufactured storage devices for years, and it has learned many lessons about what customers want. The fruits of those lessons can be found in the FileSafe 8500, which manages to make the backup process easy, flexible, and powerful.

Using quarter-inch DC-2000-style cartridges, the FileSafe 8500 has a maximum capacity of 300Mb with data compression, comes only in an internal model for PC compatibles, and has a suggested retail price of \$895. Mountain has a similar internal backup drive for MCA computers, the FileSafe 8000 Plus, which has a suggested retail price of \$995.



The FileSafe 8500 is more expensive than other drives with similar capacities, but it is well worth the added cost for those who want backups to take as little time as possible. The FileSafe 8500 connects to your computer's IDE interface, where other tape drives typically connect to the

slower floppy interface. We found that backing up 27Mb of data took 4 minutes and 55 seconds without data compression and 4 minutes and 17 seconds with 50 percent data compression. That's about one-third the time taken by a tape drive using the floppy interface.

The 8500 comes with everything you need to install it, including rails to mount it in a drive bay, the controller cable, and a Y-splitter cable to draw current from the computer's power supply. The installation process takes a few minutes; anyone who has installed a hard disk or floppy drive should find it simple. The FileSafe software loads through an

automated procedure that prompts you along the way with setup and configuration questions. The software uses menu boxes and function keys to initiate most commands, select files, and perform other tasks. It is easy to use, and context-sensitive Help is available. Over time, however, you'll probably want a quicker way to perform some backup or restore operations, and Mountain offers several options. You can execute backup commands from the DOS prompt using DOS-like commands and put several of these commands into a FileSafe batch file. Just like a DOS batch file, it will execute the series of commands when it is run. Unfortunately, there's no easy way to write these batch files from within the

FileSafe software. You'll have to create them elsewhere and then save them as ASCII files.

The spiral-bound manual covers all the topics in a detailed yet conversational manner, and includes frequent screen shots. If you run into a problem, a lengthy troubleshooting guide should get you back on track quickly. Sprinkled throughout the manual are useful tips on how and when to best use FileSafe's various features. For each type of backup (mirror, file-by-file, and so forth), the manual offers a paragraph discussing the real-life situations for which the procedure is best suited.

Mountain backs the FileSafe 8500 with a two-year warranty on parts and labor. Toll-free technical sup-

port lines are staffed from 7 A.M. to 4 P.M. (PST) weekdays. If you run into a problem outside these hours, you can try Mountain's automated technical support line available 24 hours a day. It works like a phone mail system, leading you through a series of questions to get to the area that is causing you trouble.

Users who want to periodically back up 30Mb or so of data and don't mind waiting 10 to 15 minutes for the backup to take place will find the FileSafe 8500 too expensive for the payback it provides. But if you back up larger amounts of data, need a tape drive to back up data on a network, or want a drive that can quickly back up all the drives in your office, then the FileSafe 8500 is an excellent choice.

Capacity: 300Mb with data compression. **Price:** \$895. **Company:** Mountain Network Solutions, 240 East Hacienda Ave., Campbell, CA 95008-0300, (800) 458-0300.

Tecmar MiniVAULT 250

The MiniVAULT 250 offers all the standard features you'd expect in a tape backup drive, plus superior documentation, excellent backup software, and a long, two-year warranty.

We reviewed the external drive for PC-compatibles, which uses quarter-inch DC-2000-type cartridges. The external models for PC-compatibles and MCA machines cost \$639 (\$789 with internal power supplies). If your system has an open connector on the drive controller, you can attach either drive. If you need a controller board, Tecmar sells an ISA board for \$229 and an MCA board for \$249. Internal drives for PC-compatibles cost \$519; Tecmar offers no internal unit for MCA computers.

Installing the MiniVAULT is a simple procedure that requires you to connect the included ribbon cable to the controller socket and the power cable to one of the computer's power



supply connectors. The MiniVAULT's software installs automatically. Once the software is installed, you can run a setup program for selecting screen colors and a basic or advanced configuration menu. The basic menu will be found adequate by most users.

The software becomes familiar

quickly, and menu options are clearly shown and described on the screen. Menu selections are made using function keys. Context-sensitive help is available at any time. You can choose to back up individual files or the entire contents of subdirectories, directories, or the hard disk itself, or only files that have been changed since the last backup. You can also set an unattended backup to occur.

If you do want to deal with more complex batch files, MiniVAULT lets you write them using DOS-like commands. These are powerful and offer virtually all the options available from the MiniVAULT menu-driven software. They take longer to master than the menu-driven software, but once you're familiar with them you can call them quickly at any time from the DOS prompt and avoid working your way through several menu commands.

You can also create batch files for backup operations from the menu program. The process is much easier than writing a batch file from DOS, and there's no need to know EDLIN or other DOS commands.

Everything is menu driven; just follow the prompts and make selections using the function keys for the type of backup and files you want backed up.

The manual is well written and addresses all backup options in detail. Not only does it cover how to back up files, it also offers useful advice on choosing a backup strat-

egy. Such information is often overlooked in manuals, and is every bit as important as knowing how to back up your files.

MiniVAULT supports one level of data compression, which doubles the tape capacity to the maximum of 250Mb. When backing up the entire contents of a hard disk (approximately 27Mb) the process took 11 minutes and 48 seconds without data compression and 8 minutes and 3 seconds with data compression.

Tecmar backs the drive with a two-year parts-and-labor warranty, twice what many manufacturers offer. Toll-

free technical support is available from 7 A.M. to 8 P.M. Pacific Standard Time weekdays. Here, too, hours are a bit more generous than you might find from other manufacturers. Finally, Tecmar maintains a bulletin board service that users can use to obtain technical and product information.

The MiniVAULT 250 is an excellent value, although it's a bit more expensive than some other drives you'll find. The extra money pays for excellent features and software that provide a great deal of control over the backup process.

Capacity: 250Mb with data compression. **Price:** \$639 for external PC-compatible or MCA models (\$789 with internal power supply); \$519 for internal PC-compatible model. **Company:** Tecmar, 6225 Cochran Rd., Solon, OH 44139, (216) 349-1009.

(continued from page 85)

For some users, running FDISK and FORMAT on a hard disk is rarely, if ever, done. The potential for destroying one's hard disk and hours of work is definitely lurking. We highly recommend Kingston Technology clarify their manual and hold the user's hand a little more tightly throughout the partitioning and formatting process. Otherwise, the manual is logically broken up into the simple steps required to configure and use the Data Traveler.

AT CRUISING SPEED

The Data Traveler worked quite admirably, even though it was transmitting data through a parallel printer cable. Our benchmark tests placed the Data Traveler as the drive with the highest data transfer rate. When operating some meatier programs from the Data Traveler, loading took almost twice as long as our test system's hard disk, but this performance is very good considering the nimble 13-millisecond access time of our test system.

An amber light provides the user

with visual feedback that the drive is operating. A constant green light indicates power, which can be important if you are printing. Since the Data Trav-

eler uses your parallel printer port, it must be on for you to print. Printing through the Data Traveler was transparent and trouble-free.

Product Overview

Product: Data Traveler (105MB version)

Maker: Kingston Technology Corp

Retail price: \$1095

Includes: Data Traveler drive, DB25 cable, 3.5- and 5.25-inch installation software and power cord.

Phone: 714-435-2600

Fax: 714-435-2699

Compatibility: PC/XT/AT/386/486, PS/1, PS/2

Requires: DOS 3.3 or greater and parallel printer port.

A ROAD BLOCK TO HELP

Technical support is free (except for the call) and unlimited. However, we were unimpressed with the help. To receive technical support, we had to call the main Kingston Technology phone number and be transferred to their technical support department. After leaving a voice mail message, we received a return call within an hour. The technician couldn't answer our simple question and referred us to a senior technician.

Kingston Technology provides a one-year warranty through its dealers for defective material and workmanship. Otherwise, the buyer must settle for replacement or repair of the product.

The Data Traveler provides affordable storage that is simple to use and easy to carry. Its no-nonsense installation provides DOS-literate users with the shortest route to portable storage.

COMPARISON CHART: TAPE BACKUP SYSTEMS UNDER \$800

Make/Model	Mounting	Type of Format	Max. Tape Capacity: Uncompressed/Compressed	Data Transfer Rate	Type of Controller	Power Supply	Power Consumption (Watts)	Software Included	Software Features	Other Features	Network Compat.	Price
Alloy Retriever/125ci	I	QIC-40	60Mb/125Mb	500K/sec.	floppy	PC	7	ResQ120	file-by-file, batch backup/restore	brushless, direct drive motor	Novell, 3COM, IBM TokenRing	\$395
Retriever/125ce	E	QIC-40	60Mb/125Mb	500K/sec.	proprietary	own	7	ResQ120	file-by-file, batch backup/restore	brushless, direct drive motor	Novell, 3COM, IBM TokenRing	495
Retriever/250ci	I	QIC-40	120Mb/250Mb	500K/sec.	floppy	PC	7	ResQ120	file-by-file, batch backup/restore	brushless, direct drive motor	Novell, 3COM, IBM TokenRing	525
Retriever/250ce	E	QIC-40	120Mb/250Mb	500K/sec.	proprietary	own	7	ResQ120	file-by-file, batch backup/restore	brushless, direct drive motor	Novell, 3COM, IBM TokenRing	625
CMS T2120AT	I	QIC-40	60Mb/120Mb	500K/sec.	floppy	PC	10	none	—	—	No	\$359
T2120XT	I	QIC-40	60Mb/120Mb	500K/sec.	floppy	PC	10	none	—	—	No	495
T2120ATE	E	QIC-40	60Mb/120Mb	500K/sec.	floppy	own	10	none	—	—	No	519
CORE International CORETape Light Internal	I	QIC-80	—/300Mb	500K/sec.	floppy	PC	—	none	—	advanced error correction, auto unattended backup	Novell	\$350
CORETape Light External	E	QIC-80	—/300Mb	500K/sec.	floppy	PC	—	none	—	advanced error correction, auto unattended backup	Novell	610
Maynard Archive XL 5240i	I	QIC-80	60Mb/—	1.2Mb/min.	floppy	PC	15	QICstream	file-by-file, built-in error correction	multiple backups per tape, password protection	Novell, 3COM, IBM TokenRing	\$399

I = Internal E = External All prices are U.S. suggested list. — = Information not available at press time. N/A = Not applicable

Make/Model	Mounting	Type of Format	Max. Tape Capacity: Uncompressed/Compressed	Data Transfer Rate	Type of Controller	Power Supply	Power Consumption (Watts)	Software Included	Software Features	Other Features	Network Compat.	Price
Archive XL 5540i	I	QIC-80	60Mb/—	2.4Mb/min.	floppy	PC	15	QICstream	file-by-file, built-in error correction	multiple backups per tape, password protection	Novell, 3COM, IBM TokenRing	399
Archive XL 5580i	I	QIC-80	120Mb/—	2.4Mb/min.	floppy	PC	15	QICstream	file-by-file, built-in error correction	multiple backups per tape, password protection	Novell, 3COM, IBM TokenRing	499
Archive XL 5240e	E	QIC-80	60Mb/—	1.2Mb/min.	floppy	own	15	QICstream	file-by-file, built-in error correction	multiple backups per tape, password protection	Novell, 3COM, IBM TokenRing	579
Archive XL 5540e	E	QIC-80	60Mb/—	2.4Mb/min.	floppy	own	15	QICstream	file-by-file, built-in error correction	multiple backups per tape, password protection	Novell, 3COM, IBM TokenRing	579
Tallgrass Technologies FileSECURE FS120i												
	I	QIC-40	60Mb/120Mb	2.2Mb/min.	floppy	PC	12	FileSECURE	file-by-file, menu driven		Novell, NETBIOS	\$495
FileSECURE FS250i	I	QIC-80	120Mb/250Mb	2.2Mb/min.	floppy	PC	12	FileSECURE	file-by-file, menu driven		Novell, NETBIOS	575
FileSECURE FS120e	E	QIC-40	60Mb/120Mb	2.2Mb/min.	floppy	own	12	FileSECURE	file-by-file, menu driven		Novell, NETBIOS	749

TAPE BACKUP SYSTEM MANUFACTURERS

Alloy Computer Products, Inc. One Bringham St., Marlborough, MA 01752, (508) 481-8500	CMS Enhancements Inc. 2722 Michelson Dr., Irvine, CA 92715, (714) 222-6000	CORE International 7171 N. Federal Hwy., Boca Raton, FL 33487, (407) 997-6044	Tallgrass Technologies Corp. 11100 W. 82nd St., Lenexa, KS 66214, (913) 492-6002
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High-Speed Modems

Here are five 9600-bps modems with error protection and file compression all at a reasonable cost. Our tests show which models save you the most money.

Portable computers, telecommuting, and the use of third-party communications and data facilities have caused a tremendous increase in the number of people that communicate by modem. You're not the only one in your office that can reach out and touch someone; your computer can, with a little help, just as easily reach out and touch another computer.

And as more and more computer users take to the road, adopting notebook computers and other portables, modems are no longer specialty items. A number of new notebook computers even include built-in modems as standard equipment.

So You Want To Buy a Modem

Whether you need a modem at all

should be obvious: do you often need to transfer files to a remote computer, and does that remote computer have a modem and telephone line? If so, you're a candidate. Once you decide to take the plunge, however, the buying process becomes more complicated. A maze of speeds, standards, and arcane codes—not to mention a wide range of prices and features—faces the buyer.

The most basic feature to consider is the modem's speed. Modem speed is usually given in *bits per second* (bps), although an older term, baud, is sometimes used. To be strictly accurate, baud and bps aren't interchangeable; the baud rate of a high-speed modem is sometimes a fraction of its transmission speed in bps. Most manufacturers and books have accepted bps as the standard unit of measurement.

Ten years ago, a 300-bps modem

would serve almost all PC users' needs. Today's market is essentially two-tiered: buyers have to choose between modems that transmit at 2400 bps and 9600 bps. 2400 bps has been the standard speed for modem transmission for a few years, and modems that use this standard are inexpensive (often under \$100) and popular. Although prices of 9600-bps modems have come down (from astronomical levels into the \$300 to \$600 range), these faster models are still pricey enough to make some buyers consider the older standard.

The difference, however, is dramatic. One might expect a 9600-bps modem to transmit four times faster than a 2400-bps model. But our testing showed that the 9600-bps modems, because of their built-in data compression algorithms, performed 16 to 19 times faster. (For this reason, you'll sometimes see specifica

tions that say something like "effective transmission rate of 38,400 bps using data compression and error correction." While these claims are by no means false, such speed requires a modem using the same compression and correction techniques at the other end.) Note also that faster modems can communicate with slower modems, at the slower device's speed; if you do so most of the time, however, you're probably wasting the extra money you've spent for the high speed capability.

In this, Part 1 of this article, we'll take a look at five popular 9600-bps modems. Part 2, in the next issue, will discuss more 9600-bps models as well as some 14,400-bps modems. Before we get started on with the hands-on evaluation, however, a little bit of background and explanation is in order to help clarify the quagmire of abbreviations and unique terms associated with modem communications.

The term *modem* was fabricated from the words *modulator* and *demodulator*. A modulator changes a fixed signal, known as a carrier, to reflect a series of bits of information, and these variations are decoded back into information by a demodulator. That's how radio transmission works, and transmission of computer data by modem is very similar—and, just as AM and FM radio use different modulation techniques, several methods of data transmission are popular.

Standard Transmission

Take 1200-bps communication as an example. A communications standard called the Bell 212A protocol is common in the United States, while most modems elsewhere use the V.22 standard established by the CCITT (*Comité consultatif internationale de télégraphie et téléphonie*), an international committee that adopts stan-

dards for such things. The two protocols don't mix; if you're transmitting a file in one format, a modem using the other won't understand what you're sending.

Another term you'll see crop up in modem specs is the term *bis*. *Bis* is French for "second," or "encore," and it is used by the CCITT to designate the second in a family of related standards. For example, two of the standards we'll look at shortly are V.42 and V.42*bis*.

Here's a quick rundown of techniques. Bell 103 and V.21 are used at 300 bps; Bell 212A and V.22, at 1200 bps. At 2400 bps, the international standard is called V.22*bis*. For 9600-bps transmission, there are several standards. One, called V.29, is a half-duplex standard—meaning that one modem transmits while the other listens, rather than the usual technique in which both modems speak simultaneously—commonly used in fax machines. Another is V.32, a full duplex standard. Because in the past it was very expensive to manufacture 9600-bps modems that used the V.32 standard, manufacturers came up with their own methods of getting higher transmission speeds. The HST standard from U.S. Robotics, for example, would transmit data at full speed in one direction and much slower (450 bps) in the reverse direction. This approach allowed the direction of the channels to be reversible, so the computer with the most data to send could always use the high-speed channel. Hayes and Telebit also developed their own proprietary high-speed transmission protocols. The problem with these proprietary protocols is obvious: They're unique, and if you're communicating with another computer, you have to make sure that its modem is compatible.

Today, special semiconductor chip sets that make manufacturing 9600-

bps V.32 modems fairly easy and inexpensive have become available. Thus the price of these units has come down, and the V.32 standard is becoming universal. Some proprietary modems are still available, at very low prices, so be sure you're not buying outdated technology.

Error correction and data compression are likewise controlled by standards. Error correction techniques don't have to be built into a modem, however. For example, XMODEM, YMODEM, ZMODEM, KERMIT and a host of other protocols have been implemented in software and made part of communications packages such as *SmartCom* and *CrossTalk*. At slower transmission speeds (that is, up to 1200 bps) these external software approaches work reasonably well. As transmission speed increases, however, noise on the telephone line can seriously handicap these techniques, making modems with built-in error correction necessary. Again, note that modems on both sides of the connection must support the same error correction scheme or nothing gets done.

Fixing Mistakes

One of the early error correction protocols to be developed for telephone data transmission was produced by a modem manufacturer called Microcom, and was called the Microcom Networking Protocol (MNP). Modems that use the MNP protocol can detect transmission errors and will automatically request that the sending modem re-transmit data that has been recognized as being corrupted. The error correction is done without intervention from the user; everything is automated.

There's a trade-off, of course: error-correcting modems require increased overhead and allow somewhat slower transmission of data.

Error correction schemes increase the number of bits that are sent with each character so that errors can be detected and corrected. As the number of bits added increases, the effective transmission speed, or the number of actual characters transmitted every second, drops.

Over the years, additional demands were made on the original MNP protocol. As a result, there now exist several implementations, or classes, of the protocol, ranging from Class 1 to Class 10. Only some are in widespread use; others are proprietary techniques used exclusively by Microcom. Classes 1 and 2 are strictly error correction techniques and result in efficiencies of 70 percent and 84 percent, respectively. At 2400 bps, these classes send at a maximum of 168 and about 202 characters per second (cps), respectively, instead of the maximum of 240 cps. (MNP 1 and 2 are rarely used today.) Class 3, which is based upon Class 2 but is more efficient, yields a throughput that is slightly higher than 100 percent.

The two MNP protocols most commonly used today are MNP 4 and MNP 5. MNP 4 improves throughput over unencoded transmissions, while MNP 5 incorporates a data compression technique that can cut file transmission time in half for uncompressed files, effectively doubling the transmission speed of the modem.

Microcom's error correction standards aren't the only ones. The CCITT is also involved, and has come up with V.42, which is generally acknowledged to be better than MNP 4 and in fact includes MNP 4 compatibility. Thus a V.42 modem will first try to make a connection using its own standard, but if it fails, it will then try using MNP 4. The V.42 protocol is called LAPM (Link Access Procedure for Modems) and you'll generally see that acronym dis-

played on your screen once a connection is made if the V.42 protocol is used.

A relatively new CCITT standard, V.42*bis*, is a protocol for data compression only, and requires that the V.42 protocol also be implemented for error correction. Compression rates for V.42*bis* can reach as high as 4 to 1, turning your 9,600 bps modem into a 38,400 bps machine. Bear in mind, however, that these numbers represent maximum rates that are attainable only under the best of conditions. You will almost always get results that are less impressive.

In addition to its ability to compress twice as much data as MNP 5, V.42*bis* has another advantage over the Microcom standard: higher throughput for pre-compressed files. If files compressed with PKZIP or some other compression program are sent using the MNP 5 protocol, chances are good that the throughput will drop, not increase. Why? Because MNP 5's compression scheme is the same as PKZIPs, and the files can't be compressed any further. MNP 5 isn't smart enough to recognize this, however, and tries to compress the files further, consuming time and memory. The result: a file that's no smaller and a longer transmission time than you would have had in the first place. V.42*bis*, on the other hand, checks the data to be sent to see whether it can be compressed. If not—that is, if the file's already compressed—it is sent as it stands.

Modems that use the V.42*bis* protocol are not automatically compatible with MNP 5, although many manufacturers are now including that standard as fallback technique, so be sure to check for these capabilities before buying.

Choosing Your Own

Do you need a 9600-bps modem at

all? The consensus seems to be this: if you don't mind spending the extra money, go ahead and buy one. Since a modem usually lasts a long time, you can expect to be using whatever you buy for years—and, as 9600-bps transmission is fast becoming the standard speed for data transfer, you'll be able to use the modem for a very long time.

Essentially, you can't lose if you buy the faster device: it's likely to stay useful for considerably longer, and it will save you time and money on phone and bulletin board bills because it's faster. Even if you don't need the extra speed now, you can still use the thing: it will just transmit at the speed of the modem with which it's conversing.

But if money is tight, great bargains are available in the 2400-bps modem market. Since these devices are losing favor, they're becoming cheaper and cheaper; we've seen some advertised for \$80 or \$90. And if the people you're regularly communicating with have 2400-bps modems and won't be upgrading any time soon, you may as well save a few bucks. If you transmit only text files of small to moderate size, you won't spend hours waiting for transfers to be complete. If you often send large files, however—say, color desktop publishing images—the faster modem will save you a great deal of time and is probably worth the money.

A few traps await the unwary buyer, so be alert and read specifications carefully. Make sure, for example, that the 9600-bps modem you're considering actually is a true 9600-bps modem. The V.42 and V.42*bis* standards can make a 2400-bps modem transmit at several times its conventional limit, turning in performance approaching basic 9600-bps levels. Some advertisers are using this confusion to make 2400-bps

modems look more attractive. Many 2400-bps modems also have built-in 9600-bps fax capability, meaning that they can transmit faxes but nothing else at that high speed. The only way you can be sure you have a true 9600-bps modem is to make sure that it supports the CCITT's V.32 protocol, which only applies to 9600-bps and faster modems.

Try to find a modem that has automatic "handshaking"—that is, a modem that hooks up with another device automatically, establishing the link and comparing protocols and error correction techniques without your assistance. With automatic handshaking, the modem will always try to wring out the highest performance it can from the link with the other modem.

Don't be afraid to comparison-shop for your modem. Most are well-constructed, and as long as they indicate V.32, V.42, V.42bis, and MNP 2 through 5 compatibility, you're getting a modem that will move your data quickly.

Testing

The five 9600-bps modems we've reviewed, from best performance to worst, are the U.S. Robotics Sportster 9600, Intel 9600 EX, Cardinal 9600V42, ATI 9600etc/e, and Hayes Optima 9600. It's important to note that a modem's performance will depend greatly on the software protocols used. XMODEM and YMODEM use small block sizes and are very inefficient—so much so that transmission can take twice as long as it would under a more efficient protocol, such as YMODEM-G, ZMODEM, or KERMIT.

Each modem that we examined was subject to two performance tests. Both tests involved the transmission of a 596,608-byte uncompressed file between two locations, one in Man-

hattan and one in Brooklyn. Ordinary dial-up telephone lines were used. The file contained a mixture of text and numbers—a PostScript program generated by *Ventura Publisher*, to be exact, designed to typeset several pages of text.

In our first test, we sent the file by YMODEM; in the second, it was sent by YMODEM-G, a more efficient protocol. Two telephone lines were used and the start of transmission on the transmitting end was coordinated with the start of the timer on the receiving end. When the last bit of data arrived at the receiving end the timing was terminated. The time in seconds required by each modem to send the identical file was then divided by the file size to yield the speed in characters per second.

When the YMODEM-G protocol was used, data throughput rates for these modems ranged from 3429 cps to 2882 cps—pleasantly close to the theoretical maximum of 3840 cps. When the less efficient standard YMODEM protocol was used, data transmission rates ranged from 1621 cps to 1427 cps, well short of the maximum. Compare this to 2400-bps transmission of the same file, which produced throughput of only 180 cps.

REVIEWS

ATI 9600etc-e

One of the lowest-priced 9600-bps modems available is ATI's 9600etc-e, which lists for only \$499. While this modem tied for third place in our speed evaluation tests, that's not very significant: consider that this device took only 13 seconds more to transmit our 596,608-byte file than did the first-place modem. The throughput rate was 3190 cps. Using the standard YMODEM protocol, the

transmission speed was only 1562 cps—still not bad for a low-priced alternative. And the 9600etc-e doesn't suffer from a shortage of features despite its low price: it has some that others don't, including extra front panel lights and control switches.

Modem speed is indicated by two different colored LEDs, with a combination of colors indicating the transmission speed. (Unfortunately, 4800 and 9600 bps both use the same color code.) The device also has an error-control light, which switches on when a communication link that uses an error-correcting protocol is established. Also included is a light indicating when a synchronous communication link has been established. Strangely, a basic item—a light indicating when the phone is off the hook—is not present.

Another nice feature not found on most other modems is a set of front panel switches that control the modem's operation. The switches include Data, Ans, Speed, Syn, and Test switches. The Data switch is used to redial a number when the modem is off-hook, switch between voice and data mode, or disconnect a call. The Ans switch enables the modem's auto-answer feature, and the Speed switch lets you set the modem speed from the front panel. The Syn switch toggles between asynchronous and synchronous communications, and the Test switch is used to run an internal test sequence to check out the modem. The modem also includes enough non-volatile RAM to let you store three 36-digit phone numbers and two configuration setups.

The manual is excellent and professionally prepared, with many useful illustrations and charts and a good index.

We did encounter some problems when using the modem. Despite the claim that the modem has "...auto-

matic speed adjustment on initial handshake....," we found that the ATI modem would connect at 9600 bps and steadfastly refuse to connect at 38,400 bps, the setting of the remote modem. Only after a manual configuration command was entered would the modem respond and make a proper connection. Once that connection was made, however, operation was without further incident.

Price: \$499.

Company: ATI Technologies, Inc. 3761 Victoria Park Ave., Scarborough, Ontario, CANADA, (416) 756-0718.

Cardinal 9600V42

The second-fastest modem in our tests was the Cardinal 9600V42. Like most 9600-bps modems, it supports the V.32 communications interface standard, the V.42/V.42bis protocols for error correction and data compression, and MNP 1 through 5 operation, and is, of course, compatible with other 9600-, 4800-, 2400-, 1200-, and 300-bps modems. Because of the V.42bis compatibility, maximum modem speed can be as high as 38,400 bps or 3840 cps. In our real-world tests, this modem came close



to approaching the maximum, transmitting at 3409 cps under the YMODEM-G protocol. If regular YMODEM is used, the speed drops to 1427 cps, making this modem the slowest of the lot.

The modem comes packaged in a

1.5 (H)-by-5.5 (W)-by-9.6 (D)-inch aluminum case with eight LED status indicators on the front panel. There's no indication of speed other than an LED that lights up when transmission is 4800 bps or faster. Nor does the modem show whether a link is error-correcting. These inconveniences are minor, however; most users don't even pay attention to the LEDs anyway, and certainly don't want to make a buying decision based on them alone.

The modem also comes with enough non-volatile RAM to store four phone numbers, one factory-set configuration, and two user-defined configurations. It contains circuitry that automatically adjusts communications to the data rate and standards of the remote modem.

The manual that accompanies the modem is adequate but no better: It looks like the generic type of manual many OEMs produce for private-label products. There's exactly one illustration in it, of the modem's back panel. The name of the vendor, Cardinal Technologies, is not mentioned at all in the manual, and in fact appears only on the inside cover in a trademark notice. No address or telephone number are given. (The only place you'll find any information about the manufacturer is on the box and on the warranty card, which contains an address, telephone number and fax number.) The one-year warranty is relatively short: many manufacturers provide two-year warranties, and some, like Intel, provide five.

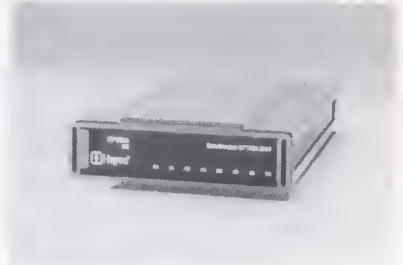
Price: \$699

Company: Cardinal Technologies, Inc. 1827 Freedom Rd., Lancaster, PA 17601, (717) 293-3000.

Hayes Optima 9600

The granddaddy of the modem business, as far as personal computer users are concerned, is Hayes Micro-

computer Products. Hayes's innovative designs produced modems that use a command language to set parameters—and to this day every modem meant for use on personal computers touts its Hayes compatibility and its use of the AT command language.



Hayes's latest entry in the 9600-bps modem market is the Optima 9600. It supports all of the usual 9600 bps protocols, including V.32, V.42, V.42bis, and MNP 2 through 5. Of course, protocols for transmission of data at slower speeds are also supported. Hayes doesn't establish list prices for its products, but this modem should be available for \$450 to \$500.

In addition to sending data asynchronously, as all other commonly used modems do, the Optima supports Hayes's AutoSync capability, so the standard asynchronous port can transmit data synchronously without a special SDLC or Bisync interface card.

The Optima 9600 also sports automatic feature negotiation, which works with other modems to analyze all features available—including modulation, error control, data compression, and the like—to establish the most efficient communications link. The modem also features automatic speed buffering, enabling it to communicate at varying speeds with other modems while communicating at a fixed interface speed if required by its attached DTE (mainframe,

minicomputer or PC).

The manual that accompanies the modem is fairly well-prepared, though it lacks an index. The program comes bundled with *SmartCom EZ*, a quick-and-dirty communications package. It's better than nothing, but just barely. Consider taking advantage of Hayes's \$35 offer to upgrade to *Smartcom Exec*.

In tests with our 596,608-byte file, connection at 38,400 bps was made immediately. Transmission speed was only 2882 cps, the poorest performance turned in by any of these modems. In our test with the YMODEM protocol, the Hayes modem didn't do much better. It checked in at 1570 cps, the second-worst time in the group.

Price: \$500.

Company: Hayes Microcomputer Products, P.O. Box 105203, Atlanta, GA 30348, (404) 840-9200.

Intel 9600EX

If you asked us to choose one 9600-bps modem that represented the cream of the crop, this would be it—not because it's the fastest (it isn't) or cheapest (it's among the most expensive). But the construction, manufacturer's support and responsiveness, trouble-free operation, and the attention to detail that Intel provides build a level of confidence that makes one very comfortable with this modem.

Although the Intel 9600EX is quite pricey—it lists for \$799—the modem comes with some extras that you don't get elsewhere. Not too long ago, whenever you bought a modem, the manufacturer also supplied you with a communications program to use with it. That's not often the case anymore; Intel, however, is the exception. Bundled with the 9600EX is a program called *Communications by*

CrossTalk. This is a customized version of Crosstalk's *Communicator* program and it is a full-function, easy-to-use program that takes full advantage of all of the modem's features.

Our first impression of the 9600EX was of its rugged appearance. Apparently Intel is also confident of the modem's durability, because each 9600EX has a five-year warranty. We know of no other modem manufacturer that does so. Intel also provides some excellent technical support staff and documentation. The support system includes a telephone setup that you can call—by voice or modem—and request any of dozens of articles or application notes that address specific areas. Problems you're having or questions you'd like answered can frequently be handled by one of these documents. If you need to speak to a



live technician, however, they're available too: Our call reached a knowledgeable fellow who was able to answer all of our questions.

The front panel of the modem has two extra indicator lights, along with the usual set. The first indicates high-speed transmission. This tri-color LED lights up in red for communication at 9600-bps, orange for 4800 bps, and green for 2400 bps, and is extinguished for any speed of 1200 bps or less. The other indicator is lit when a communication session that uses the modem's built-in error cor-

rection capabilities is taking place. (As we've said, such a session can only take place when the modem at the receiving end also has built-in error correction.)

The 9600EX supports most protocols for 9600-bps modems. These include V.32, V.42, V.42bis, and MNP 1 through 5. It also has a built-in feature negotiation capability, meaning that two modems in a connection will automatically set up a connection with the highest-performing set of features mutually available. Should the connection deteriorate during a communication session, the 9600EX will automatically fall back to 4800 bps.

Installation of the modem was quite easy: just plug it in and turn it on. Even a novice should be able to have this external modem installed and ready to go within ten minutes. If you're going to use the communications program that comes with the modem (which we highly recommend), you'll probably need another 10 or 15 minutes to install that too, but the installation procedure is simple.

We liked one additional feature: Extra non-volatile RAM (RAM that stores information even when the power is turned off) is built into the 9600EX. Enough of this special RAM is provided to allow you to store four frequently dialed phone numbers and two different startup configurations.

The modem is housed in a rugged aluminum case that measures 1.25 (H) by 5.5 (W) by 9.6 (D) inches. The heart of the unit is an Intel 80188 microprocessor, which is capable of more than the usual modem chip set and thus can handle several built-in diagnostics. These include local and analog loopback testing, local digital loopback, remote digital loopback, and a power-up self test.

The modem comes with three manuals and a command summary

reference card. One manual is an installation guide, one is a guide to the commands the modem recognizes (an extensive list), and the third is a guide to installing and using the communications program. All of the documentation is clear and well-written.

During our test communications session, the modem connected at 38,400 bps. When the file was transmitted, the actual speed was 3190 cps when we used the YMODEM-G protocol. When the ordinary YMODEM protocol was used the speed was cut in half and our actual throughput dropped to 1621 characters per second. The connections were made without difficulty and the sessions proceeded smoothly. This modem's speed let it tie for third place in our tests. An upgrade to convert the modem into a 14,400 bps device is available from Intel.

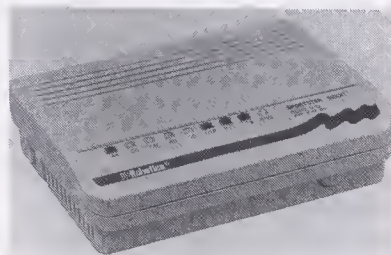
Price: \$799.

Company: Intel Corp., 5200 NE Elam Young Pkwy., Hillsboro, OR 97124-6497, (503) 629-7000.

U.S. Robotics Sportster 9600

Checking in at first place in our tests of 9600-bps modems is the Sportster 9600. This modem has an unusually

shaped plastic case that measures 6.625 (W) by 5 (D) by 1.75 (H) inches. Although the Sportster's list price (\$649) is \$150 lower than that of the Intel 9600EX, you'll find very few things missing from this modem. It even has a few extra bells and whistles that some of the others lack.



To begin with, the Sportster 9600 supports all of the popular protocols, including V.32, V.42, V.42bis, and MNP 2 through 5. The packaging may be a little misleading: it mentions V.42bis, but fails to highlight the V.42 protocol that is also included. (In order to have V.42bis, you must have V.42, but not everyone knows that.) In addition to the protocols normally found in the U.S., the V.23 and V.25 protocols, found primarily overseas, are also provided.

Uncommon features found in the Sportster include the ability to operate in a Quote mode, which makes it possible to enter phone numbers as

letters (so you can call PENnsylvania 6-5000—which will still connect you with the successor to the Pennsylvania Hotel), and the ability to hang up the phone after a specified length of inactive time. This last feature is especially useful if you tend to send very long files or a long series of files overnight, and allows for untended operation of the modem once a session has been started.

Like the other modems tested here, the Sportster has non-volatile memory—but less of it. Only one set-up configuration and only one frequently dialed phone number can be stored.

When we first set up the modem, we couldn't get it to make a connection at any rate higher than 9600 bps—surprising, since the modem supports the V.42bis data compression protocol. Once we reset the modem to the protocol and speed settings recommended in the manual, the problem cleared up. The moral: always make sure you check the settings on a new modem, and reset them when you're in doubt.

After the settings were made, the modem performed flawlessly and turned in a speed rating of 3429 bps, the fastest of the lot. This was obtained under the YMODEM-G protocol. We also tested the modem with the ordinary YMODEM protocol and saw the speed of the modem cut almost in half, to 1595 characters per second.

The manual provided with the modem is excellent and, as we noted, got us through a tricky problem. No call to customer support was necessary; there is a support line, however, should you need one.

Price: Sportster 9600 External, \$649.

Company: U.S. Robotics, Inc. 8100 N. McCormick Blvd. Skokie, IL 60076, (800) DIAL USR, (708) 982-5010.

9600bps Modems Compared: Dollar Cost to Transmit Test File

Modem	Genie 2400 Peak Hrs.	Genie 9600 off peak/peak hrs.	CompuServe 2400/9600bps
U.S. Robotics	\$16.59	\$.76 / \$1.27	\$11.60 / \$.94
Cardinal	\$16.59	\$.77 / \$1.28	\$11.60 / \$.94
Intel	\$16.59	\$.92 / \$1.54	\$11.60 / \$1.14
ATI	\$16.59	\$.92 / \$1.54	\$11.60 / \$1.14
Hayes	\$16.59	\$.98 / \$1.64	\$11.60 / \$1.21

COMPARISON CHART: MODEMS UNDER \$200

Make/Model	Speed	Auto Fall Back	* Mounting	Bus Inter-face	Standards	Hayes AT compat.	Power Supply	Software Included	Error Correction	Speaker; Vol. Ctrl.	Send Fax	Other Features	Price
Boca Research BOCAMODEM 2400 Internal	2400 baud	Y	I	8-bit	Bell 212A/103, CCITT V.22/V.22bis	Y	AC	ProComm	—	Y; Y	N		\$99
	2400 baud	Y	I	8-bit	Bell 212A, CCITT V.22bis/V.22N.21	Y	AC	FLASHlink communications	MNP5	N; N	N	call progress monitoring, auto answer, auto dial	\$119
	2400 baud	Y	E	8-bit	Bell 212A, CCITT V.22bis/V.22N.21	Y	AC	opt.	MNP5	N; N	N	call progress monitoring, auto dial, auto answer	159
	2400 baud	Y	P	N/A	Bell 212A, CCITT V.22bis/V.22N.21	Y	AC	FLASHlink communications	V.42bis, MNP5	N; N	N	call progress monitoring, auto power shutdown	179
2450MNP	2400 baud	Y	I	8-bit	Bell 212A, CCITT V.22bis/V.22N.21	Y	AC	opt.	MNP5	N; N	N	call progress monitoring, auto dial, auto answer	189
Computer Peripherals Hook-Up 2400S	2400 baud	Y	I	8-bit	Bell 212A/103, CCITT V.22bis/V.22N.21	Y	AC	Quick Link communications	none	Y; Y	N	built-in self-test diagnostics	\$119
	2400 baud	Y	I	8-bit	Bell 212A/103, CCITT V.22bis/V.22N.21	Y	AC	Quick Link communications	MNP 2-4	Y; Y	N	non-volatile memory	139
	2400 baud	Y	P	N/A	Bell 212A/103, CCITT V.22/V.21	Y	battery	Quick Link communications	none	—	N		139
	2400 baud	Y	I	8-bit	Bell 212A/103, CCITT V.22bis/V.22N.21	Y	AC	Quick Link communications	MNP 2-4	Y; Y	N	MNP5 data compression	189
Hayes Personal Modem 2400 Plus	2400/1200/300 baud	—	E	8-bit	Bell 103/212A, CCITT V.22/V.22bis	Y	AC	Smartcom for the Mac	none	Y; Y	—		\$199

I = Internal E = External P = Portable — = Information not available at press time. N/A = Not applicable

Make/Model	Speed	Auto Fall Back	* Mounting	Bus Interface	Standards	Hayes AT compat.	Power Supply	Software Included	Error Correction	Speaker; Vol. Ctrl.	Send Fax	Other Features	Price
U.S. Robotics Sportster 1200PC	1200 baud	—	I	8-bit	Bell 212A/103	Y	AC	Communications by CrossTalk	none	Y; Y	N	5-yr. warranty	\$139
Sportster 1200	1200 baud	—	E	8-bit	Bell 212A/103	Y	AC	none	none	Y; Y	N	operations summary on bottom panel, 5-yr. warranty	149
WorldPort 1200	1200 baud	—	P	N/A	Bell 212A/103, CCITT V.22/V.21	Y	AC, battery	MTEZ software	none	Y; Y	N	acoustic coupler interface	159
Sportster 2400PC	2400 baud	—	I	8-bit	Bell 212A/103, CCITT V.22bis/V.22/V.21	Y	AC	Communications by CrossTalk	none	Y; Y	N	5-yr. warranty	179
Ven-Tel Half Card 24	2400/1200/300 baud	—	I	8-bit	Bell 212A, CCITT V.22/22bis	Y	—	Communications by CrossTalk	—	Y; N	N	Comm 1-4 selectable, auto speed detection	\$175
* 2400 Plus	2400/1200/300 baud	—	E	8-bit	Bell 212A/103, CCITT V.22/22bis	Y	AC	Communications by CrossTalk	—	Y; —	N		199

MODEM MANUFACTURERS

Boca Research, Inc.

6413 Congress Ave., Boca Raton, FL 33487, (407) 997-4227

Cardinal Technologies, Inc.

1827 Freedom Rd., Lancaster, PA 17601, (800) 233-0187, (717) 293-3000

Computer Peripherals, Inc.

667 Rancho Conejo, Newbury Park, CA 91320, (805) 499-5751, (800) 854-7600

Hayes Microcomputer Products, Inc.

PO Box 105203, Atlanta, GA 30348, (404) 840-9200

U.S. Robotics

8100 McCormick Blvd., Skokie, IL 60076, (708) 982-5010

Ven-Tel, Inc.

2121 Zanker Rd., San Jose, CA 95131-2177, (408) 436-7400, (800) 538-5121

DISCOUNT PRICE GUIDE

A DIRECTORY OF LOWEST PRICES NATIONWIDE

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The Discount Price Guide staff regularly scans the country for the lowest prices available within each product category. They continually monitor newspaper and magazine advertising and maintain an ongoing phone dialog with outlets across the country. At the last moment before press time, the computer selects the lowest prices for each category. Due to the lead time necessary for the issue to reach the newsstands (several weeks), and the volatile nature of the discount marketplace, prices can fluctuate marginally up or down.

HARD DISK DRIVES

MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER	MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER
ESDI						LPS52A	52	17	N	\$209	Hard Drives Int'l
						LPS52A	52	17	N	209	Storage Devices Inc.
Micropolis						Maxtor					
MC1355	159	23	N	\$469	ET Valueline	7080A	80	19	N	275	JB Technologies
Seagate						7080A	80	17	N	279	Computer Products Corp.
ST2182E	160	16	N	875	Storage Devices Inc.	7080A	80	17	N	279	Hard Drives Int'l
ST2182E	160	16	N	949	Computer Products Corp.	7080A	80	17	Y	289	Warehouse 54
Maxtor						Western Digital					
MX4380E	338	16	N	1,150	Ralin Wholesalers	WD280A	80	20	N	285	Shecom Computers
Seagate						WD280A	80	20	N	299	FastMicro
ST2383E	338	15	N	1,159	DC Drives	WD280A	85	18	N	260	American Computing
ST2383E	338	15	N	1,360	American Computing	Toshiba					
Micropolis						MK234FCF	104	17	N	345	Shecom Computers
MC1664	340	15	N	975	Warehouse 54	Kalok					
MC1664	340	15	Y	1,099	DC Drives	KL3100	105	25	N	289	Storage Devices Inc.
MC1664	340	15	N	1,099	Hard Drives Int'l	Quantum					
MC1664	345	18	N	999	ET Valueline	LPS105A	105	17	N	289	Computer Products Corp.
Maxtor						LPS105A	105	17	N	319	JB Technologies
MX8380E	360	14	N	1,179	Computer Products Corp.	LPS105A	105	17	N	349	Hard Drives Int'l
MX8380E	360	14	N	1,199	Hard Drives Int'l	Samsung					
MX8380E	360	14	N	1,199	Storage Devices Inc.	105MB	105	16	N	319	Hard Drives Int'l
Micropolis						Toshiba					
MC1568	660	16	N	1,349	Ralin Wholesalers	MK1034	105	16	N	349	Warehouse 54
MC1568	660	16	N	1,395	Warehouse 54	MK1034	105	20	Y	369	FastMicro
MC1568	660	16	Y	1,399	DC Drives	MK1034	107	16	N	325	S.E.F.
MC1568	660	16	N	1,499	Hard Drives Int'l	Conner					
Seagate						CP30104	120	19	N	335	California Microchip
ST4766E	660	15	N	1,375	Storage Devices Inc.	CP30104	120	19	N	369	MegaHaus
ST4766E	660	15	N	1,439	Computer Products Corp.	CP30104	120	19	N	525	Quick Electronics
ST4766E	660	15	N	1,439	DC Drives	Seagate					
Maxtor						ST3144A	130	16	N	369	Quick Electronics
8760E	675	16	N	1,349	Storage Devices Inc.	ST3144A	130	16	N	379	USA Flex
8760E	675	16	N	1,395	JB Technologies	ST3144A	130	16	N	399	JDR Microdevices
8760E	675	16	N	1,399	Computer Products Corp.	ST4144A	130	18	N	329	MicroLab
Micropolis						Quantum					
MC1518	1345	14	Y	2,529	DC Drives	PRO210A	200	15	N	560	American Computing
MC1518	1345	14	N	2,599	Storage Devices Inc.	Conner					
IDE						CP3204	210	16	N	529	Computer Products Corp.
Conner						CP3204	210	16	N	539	DC Drives
CP3000	42	25	N	175	DC Drives	CP3204	210	16	N	559	Storage Devices Inc.
CP3000	42	25	N	189	Hard Drives Int'l	Quantum					
CP3000	42	25	N	205	Shecom Computers	PRO210A	210	17	N	585	Storage Devices Inc.
Maxtor						PRO210A	210	15	N	649	Hard Drives Int'l
7040A	42	19	N	195	Storage Devices Inc.	Seagate					
7040A	42	19	N	205	DC Drives	ST1239A	210	15	N	540	American Computing
Quantum						ST1239A	210	15	N	569	Quick Electronics
LPS52A	52	17	N	199	Computer Products Corp.	ST1239A	210	15	N	569	USA Flex
						Western Digital					
						WD200	210	15	N	579	Shecom Computers

For dealer addresses and phone numbers see page 108 NA denotes not available * For further explanation see Street Price Buying Tips

STREET PRICE GUIDE: HARD DISK DRIVES

MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER	MAKE/ MODEL	CAPACITY (Mb)	SPEED (ms)	CONTROLLER	STREET PRICE	DEALER
Seagate						Fujitsu					
ST2383A	338	16	N	\$1,099.95	Lyco Computer	M2624S	520	12	N	\$1,229	MegaHaus
ST2383A	338	16	N	1,159	JDR Microdevices	M2624S	520	12	N	1,339	DC Drives
MFM						M2624S	520	12	N	1,339	Quick Electronics
Seagate						Micropolis					
ST1100	80	15	N	549	JB Technologies	MC1588	660	16	N	1,288	DC Drives
ST4096	80	28	N	449	Hard Drives Int'l	MC1588	660	16	N	1,499	Hard Drives Int'l.
ST4096	80	28	N	569	JDR Microdevices	MC1588	660	16	N	1,645	Shecom Computers
ST1100	88	15	N	619	DC Drives	Fujitsu					
RLL						M2263S	675	16	N	1,219	Quick Electronics
Seagate						M2263S	675	16	N	1,249	DC Drives
ST238R	30	65	N	200	DC Drives	M2263S	675	16	N	1,299	MegaHaus
ST157R	50	28	N	219.95	Lyco Computer	Maxtor					
ST157R	50	28	Y	259	Computer Products Corp.	Tahiti	920	35	N	2,899	Computer Products Corp.
SCSI						Seagate					
Quantum						ST41200N	1000	15	N	1,975	JB Technologies
LPS52S	52	12	N	209	Computer Products Corp.	Maxtor					
LPS52S	52	12	N	219	Storage Devices Inc.	PO 12S	1025	13	N	1,999	Computer Products Corp.
LPS52S	52	17	N	239	JB Technologies	Micropolis					
Seagate						MC1598	1035	14	N	2,095	Warehouse 54
ST177N	60	20	N	229	Computer Products Corp.	MC1598	1035	14	N	2,129	Storage Devices Inc.
Conner						MC1598	1035	14	N	2,199	Hard Drives Int'l
CP30080	84	18	N	325	Storage Devices Inc.	Seagate					
CP30080	84	18	N	329	DC Drives	ST41200N	1037	16	N	1,995	Storage Devices Inc.
Seagate						Imprimis					
ST296N	85	28	N	239	Computer Products Corp.	ST41200N	1050	17	N	1,899	MicroLab
ST296N	85	28	N	265	Storage Devices Inc.	ST41200N	1050	14	N	1,899	Warehouse 54
ST296N	85	28	N	269	DC Drives	ST41200N	1050	14	N	2,099	Hard Drives Int'l.
Conner						Seagate					
CP30100	104	25	N	379	JB Technologies	ST41200N	1050	15	N	1,899	Computer Products Corp.
Quantum						Maxtor					
LPS105S	105	12	N	319	Computer Products Corp.	PO 12S	1059	13	N	1,975	Storage Devices Inc.
LPS105S	105	12	N	339	Storage Devices Inc.	Fujitsu					
LPS105S	105	12	N	349	MegaHaus	M2266S	1079	12	N	1,869	DC Drives
Conner						M2266S	1079	12	N	1,969	Storage Devices Inc.
CP30100	120	18	N	389	Storage Devices Inc.	M2266S	1079	12	N	1,989	MegaHaus
Quantum						Maxtor					
PRO210S	210	15	N	639	Storage Devices Inc.	PO 12S	1200	13	N	1,995	JB Technologies
Seagate						Micropolis					
ST4350N	300	18	N	1,129	Storage Devices Inc.	MC1528	1350	15	N	2,379	Quick Electronics
ST4350N	300	18	N	1,149	Computer Products Corp.	MC1528	1350	14	N	2,439	DC Drives
Fujitsu						MC1528	1350	14	N	2,699	Hard Drives Int'l.
M2622S	330	12	N	1,089	MegaHaus	Seagate					
M2622S	330	12	N	1,095	Storage Devices Inc.	ST41650N	1420	15	N	2,399	Computer Products Corp.
M2622S	330	12	N	1,239	DC Drives	ST41650N	1420	15	N	2,439	Storage Devices Inc.
Imprimis						ST41650N	1420	15	N	2,479	DC Drives
ST4376N	330	17	N	1,199	Hard Drives Int'l.	Maxtor					
Seagate						MX117S	1470	13	N	2,499	JB Technologies
ST4376N	330	17	N	1,119	Computer Products Corp.	MX117S	1470	13	Y	25,99	Hard Drives Int'l.
ST4376N	330	17	N	1,169	DC Drives	Micropolis					
ST4376N	330	17	N	1,199	JB Technologies	MC1548	1748	14	N	3,189	DC Drives
						MC1548	1748	14	N	3,259	MegaHaus
						MC1548	1748	14	N	3,499	Storage Devices Inc.

MEMORY UPGRADE

TYPE/ CAPACITY	SPEED	PRICE	DEALER	TYPE/ CAPACITY	SPEED	PRICE	DEALER
SIMM				256K x 8	100	\$17	H.Co. Computer
1Mb x 8	80	\$39	Hard Drives International	256K x 9	60	13.65	Worldwide Tech.
1Mb x 8	80	39	MicroTech	256K x 9	70	13	Worldwide Tech.
1Mb x 8	80	43	H.Co. Computer	256K x 9	70	15	Access Computer
1Mb x 8	100	40	Worldwide Tech.	256K x 9	70	15	Hard Drives International
1Mb x 8	100	45	H.Co. Computer	256K x 9	70	18	H.Co. Computer
1Mb x 9	60	40	Shecom	256K x 9	80	12	MicroTech
1Mb x 9	60	45	MicroTech	256K x 9	80	12.65	Worldwide Tech.
1Mb x 9	60	47	Access Computer	256K x 9	80	15	H.Co. Computer
1Mb x 9	60	48	Worldwide Tech.	256K x 9	100	9.75	Worldwide Tech.
1Mb x 9	70	39	Shecom	256K x 9	100	15	H.Co. Computer
1Mb x 9	70	39	Warehouse 54	SIPP			
1Mb x 9	70	42	MicroTech	1Mb x 7	70	45	Verticom
1Mb x 9	70	44	Hard Drives International	1Mb x 8	80	43	Access Computer
1Mb x 9	70	46	H.Co. Computer	1Mb x 9	60	46	Verticom
1Mb x 9	70	46	Worldwide Tech.	1Mb x 9	60	50	Worldwide Tech.
1Mb x 9	80	38	Shecom	1Mb x 9	70	46	Access Computer
1Mb x 9	80	40	MicroTech	1Mb x 9	70	48	Worldwide Tech.
1Mb x 9	80	44	Hard Drives International	1Mb x 9	80	43	Verticom
1Mb x 9	80	44	Worldwide Tech.	1Mb x 9	80	46	Worldwide Tech.
1Mb x 9	80	45	Access Computer	1Mb x 9	100	42.50	Worldwide Tech.
1Mb x 9	80	48	H.Co. Computer	4Mb x 9	60	205	Access Computer
1Mb x 9	100	40	Worldwide Tech.	4Mb x 9	80	160	Verticom
1Mb x 9	100	44	H.Co. Computer	4Mb x 9	80	160	Verticom
2Mb x 8	80	109	Hard Drives International	4Mb x 9	80	165	Access Computer
4Mb x 8	80	159	H.Co. Computer	256K x 9	60	14	Verticom
4Mb x 8	80	159	Hard Drives International	256K x 9	60	16.65	Worldwide Tech.
4Mb x 8	80	165	Access Computer	256K x 9	70	13	Verticom
4Mb x 9	60	165	Shecom	256K x 9	70	15	Worldwide Tech.
4Mb x 9	60	185	MicroTech	256K x 9	80	12	Verticom
4Mb x 9	60	199	Worldwide Tech.	256K x 9	80	14	Access Computer
4Mb x 9	70	145	Shecom	256K x 9	80	14.65	Worldwide Tech.
4Mb x 9	70	149	Warehouse 54	256K x 9	100	11.75	Worldwide Tech.
4Mb x 9	70	150	MicroTech				
4Mb x 9	70	169	Hard Drives International				
4Mb x 9	70	175	Access Computer				
4Mb x 9	70	175	Worldwide Tech.				
4Mb x 9	70	179	H.Co. Computer				
4Mb x 9	80	135	Shecom				
4Mb x 9	80	145	MicroTech				
4Mb x 9	80	165	Worldwide Tech.				
4Mb x 9	80	189	H.Co. Computer				

For dealer addresses and phone numbers see page 108

FLOPPY DISK DRIVES

MAKE/ MODEL	MOUNT- ING	STREET PRICE	DEALER	MAKE/ MODEL	MOUNT- ING	STREET PRICE	DEALER
3.5/DOUBLE DENSITY				5.25/DOUBLE DENSITY			
Chinon	i	\$46	Verticom Corp.	Chinon	i	\$46	Verticom Corp.
Chinon	i	49.95	Lyc0 Computer	Chinon	i	49	MidWest MicroPeripherals
Chinon	i	50	Quick Electronics	Chinon	i	49	Quick Electronics
Chinon	i	51	MidWest MicroPeripherals	Chinon	i	51	Nationwide Computer
Mitsumi	i	45	Syntax Computer	Mitsumi	i	40	Syntax Computer
Sony	i	59	ET Valueline	Sony	i	50	Telemart
Sony	i	70	Telemart	Teac	i	57	Mile Hi Micro
Sony	i	79	Harmony Computers	Teac	i	57	DC Drives
Teac	i	59	GEMS Computers	Teac	i	58	California MicroChip
Teac	i	59	DC Drives	Teac	i	89.95	Jameco Electronic
Teac	i	63	CMO	Toshiba	i	55	MidWest MicroPeripherals
3.5/HIGH DENSITY				Toshiba	i	59	Bulldog Computer
Chinon	i	55	Verticom Corp.	Toshiba	i	59	ET Valueline
Chinon	i	58	MidWest MicroPeripherals	Toshiba	i	59	FastMicro
Chinon	i	59	ComputAbility	5.25/HIGH DENSITY			
Chinon	i	58.95	Lyc0 Computer	Chinon	i	55	Quick Electronics
Citizen	i	55	MidWest MicroPeripherals	Chinon	i	55	Verticom Corp.
Ergo	i	49	California MicroChip	Chinon	i	58	Nationwide Computer
Ergo	i	49	Mile Hi Micro	Chinon	i	59	ComputAbility
Fujitsu	i	56	Aberdeen	Chinon	i	59.95	Lyc0 Computer
Mitsumi	i	47	Amka, Inc.	Epson	i	59	Fridays
Mitsumi	i	50	Syntax Computer	Fujitsu	i	56	Aberdeen
Mitsumi	i	55	US Turbo Sys.	Mitsumi	i	51	Amka, Inc.
Mitsumi	i	56	Mile Hi Micro	Mitsumi	i	52	Syntax Computer
Panasonic	i	56	Aberdeen	Mitsumi	i	54	US Turbo Sys.
Sony	i	58	Dynamax	Mitsumi	i	56	Mile Hi Micro
Sony	i	59	ET Valueline	Mitsumi	i	58	APlus Computer
Sony	i	59	MidWest MicroPeripherals	Panasonic	i	56	Aberdeen
Sony	i	63	GEMS Computers	Sony	i	87	Telemart
Teac	i	50	Warehouse 54	Teac	i	50	Warehouse 54
Teac	i	53	Amka, Inc.	Teac	i	56	Amka, Inc.
Teac	i	57	Shecom Computers	Teac	i	57	Shecom Computers
Teac	i	58	Mile Hi Micro	Teac	i	59	Mile Hi Micro
Teac	i	59	FastMicro	Teac	i	60	CMO
Teac	i	60	CMO	Teac	i	61	Nationwide Computer
Teac	i	61	Nationwide Computer	Teac	i	63	GEMS Computers
Toshiba	i	50	Warehouse 54	Toshiba	i	50	Warehouse 54
Toshiba	i	57	MicroLab	Toshiba	i	57	MicroLab
Toshiba	i	59	Bulldog Computer	Toshiba	i	59	Bulldog Computer
Toshiba	i	67.95	Lyc0 Computer	Toshiba	i	69.95	Lyc0 Computer

I = Internal E = External For dealer addresses and phone numbers see page 108

STREET PRICE GUIDE: DEALERS

DEALERS

APlus Computers

398 Lemon Creek Dr., Unit H,
Walnut, CA 91789, Phone: (800)
443-5373

Aberdeen

1125 S. Maple Ave., Unit P,
Montebello, CA 90640, Phone:
(800) 552-6868

Access Computer Technology

2225 El Camino Real, Santa
Clara, CA 95050, Phone: (800)
359-6800

American Computing Tech.

4124 Rosemead Blvd., #A,
Rosemead, CA 91770, Phone:
(800) 638-6698

Amka, Inc.

15342-B E. Valley Blvd., City of
Industry, CA 91746, Phone: (818)
369-2121

Arlington Computer Products

1970 Carboy, Mt. Prospect, IL
60056, Phone: (800) 548-5105

Bulldog Computer Products

610 Industrial Park Dr., Evans,
GA 30809, Phone: (800) 438-6039

CAD & Graphics

1301 Evans, San Francisco, CA
94104, Phone: (800) 288-1611,
(415) 647-9671

CMO Corporation

101 Reighard Ave., Williamsport,
PA 17701, Phone: (800) 233-8950

California Microchip

9240 Deering Ave., Chatsworth,
CA 91311, Phone: (800) PRO-
CHIP, (818) 884-3660

CallSoft

2 Riverview Dr., Somerset, NJ
08873, Phone: (800) 777-5014

Compu\$ave

4209 S. 37th St., Dept. S8,
Phoenix, AZ 85040, Phone: (800)
544-8302

Compuclassics

PO Box 10598, Canoga Park, CA
91309, Phone: (800) 733-3888

ComputAbility

PO Box 17882, Milwaukee, WI
53217, Phone: (800) 558-0003

Computer Discount Warehouse

2840 Maria, Northbrook, IL
60062, Phone: (800) 233-4426

Computer Input Products

1301 Evans Ave., San Francisco,
CA 94124, Phone: (800) 825-1187

DC Drives

1110 NASA Rd., 1, Ste. 304,
Nassau Bay, TX 77058, Phone:
(800) 872-6007

Damark

7101 Winnetka Ave., N.,
Minneapolis, MN 55429-0900,
Phone: (800) 729-9000

Dustin Discount

20969 Ventura Blvd., Ste. 13,
Woodland Hills, CA 91364, Phone:
(800) 274-6611

Dynamax

4044 Clipper Ct., Fremont, CA
94538, Phone: (800) 886-2882

ET Valueline

7350 N. Linder Ave., Skokie, IL
60077, Phone: (800) 395-1000

Essence Group

17815 Newhope St., #G, Fountain
Valley, CA 92708, Phone: (714)
546-3110

Exsel, Inc.

2200 Brithton-Henrietta Rd.,
Rochester, NY 14623, Phone:
(800) 624-2001

FastMicro

4405 E. Baseline Rd., Phoenix,
AZ 85044, Phone: (800) 441-3278

Focus Computer

1303 46th St., Brooklyn, NY
11219, Phone: (800) 223-3411

Fraturdays

980 S. First St., San Jose, CA
95110, Phone: (800) 488-6575

GEMS

2115 Old Oakland Rd., San Jose,
CA 95131, Phone: (800) 743-9333

H.Co. Computer

17922 Sky Park Circle, #F, Irvine,
CA 92714, Phone: (800) 726-2477

Hard Drives International

1912 W. 4th St. Dept. HDU,
Tempe, AZ 85281, Phone: (800)
767-DISK

Harmony Computers

1801 Flatbush Ave., Brooklyn, NY
11210, Phone: (800) 441-1144

Hi Tech USA

1562 Centre Point Dr., Milpitas,
CA 95035, Phone: (800) 831-2888

Insight Software

1912 W. 4th St., Tempe, AZ
85281, Phone: (800) 998-8030

J&R Computer World

15 Park Row, New York, NY
10038, Phone: (800) 221-8180

JB Technologies

5105 Maureen Lane, Moorpark,
CA 93021, Phone: (805) 529-0908

JDR Microdevices

2233 Samaritan Dr., San Jose,
CA 95124-9923, Phone: (800) 538-
5000

Jameco Electronics

1355 Shoreway Rd., Belmont, CA
94002, Phone: (800) 831-4242

Kenosha Computer

2133 91st St., Kenosha, WI
53140, Phone: (800) 255-2989

Laser Press & Graphics

4888 Stamp Rd., Marlow Heights,
MD 20748, Phone: (800) 628-4517

Loma Computers

946 Loma Dr., Hermosa Beach,
CA 90254, Phone: (800) 369-2846

Lycu Computer

PO Box 5068, Jersey Shore, PA
17740, Phone: (800) 233-8760

MegaHaus Drives

1110 NASA Rd., 1, Ste. 306,
Houston, TX 77058, Phone: (800)
426-0560

MicroLab

23976 Freeway Park Dr., Farming-
ton Hills, MI 48335, Phone: (800)
677-7900

MicroProfessionals

19261 Burnham, Ste. 100,
Lansing, IL 60438, Phone: (800)
800-8300

MicroSales

7715 NW 56 St., Miami, FL
33166, Phone: (800) 222-8324

MicroTech

7304 15th Ave., NE, Seattle, WA
98115, Phone: (800) 521-9035

MicroWarehouse

PO Box 3014, Lakewood, NJ
08701-3014, Phone: (800) 367-
7080

MidWest Computer Works

350 Lexington Dr., Buffalo Grove,
IL 60089, Phone: (800) 669-5208

MidWest MicroPeripherals

6910 US Rte. 36 East, Fletcher,
OH 45326, Phone: (800) 423-8215

Mill Hi Micro

10525 East 40th Ave. #203,
Denver, CO 8239, Phone: (800)
800-9828

Nationwide Computer

PO Box 7AQ, Jersey City, NJ
07307, Phone: (800) 777-1054

PC Connection

6 Mill St., Marlow, NH 03456,
Phone: (800) 243-8088

PC Zone

18005 NE 68th St., Ste., A110,
Redmond, WA 98052, Phone:
(800) 252-0286

Page Computer

1779 B Westwood Blvd, Los
Angeles, CA 90024, Phone: (800)
266-0055

Paradise

PO Box 890553, Dallas, TX
75389-0553, Phone: (800) 348-
4727

Publisher's Toolbox

6606 Carlsbad Dr., Madison, WI
53705, Phone: (800) 233-3898

Publishing Perfection

PO Box 307, Menomonee Falls,
WI 53051, Phone: (800) 782-5974

Quick EElectronics

10800 76th Court N., Largo, FL
34647, Phone: (800) 800-5500

Ralin Wholesalers

PO Box 450, Orchard Park, NY
14127, Phone: (800) 752-9512

S.E.F. (Sound Electric Flight)

4545 Industrial St., 5N, Simi
Valley, CA 93063, Phone: (800)
279-4824

Shecom Computers

22755 Savi Ranch Pkwy., #G,
Yorba Linda, CA 92687, Phone:
(800) 366-4433

Soft Comp USA

3701 Harbor Blvd., Ste. 211F,
Santa Ana, CA 92704, Phone:
(800) 922-3544

Software Add Ons

3331 Street Rd., Ste., 155,
Bensalem, PA 19020, Phone:
(800) 822-8088

Software Unlimited

2465 W. 12th St., Ste. 5, Tempe,
AZ 85281, Phone: (800) 926-SOFT

Star Ware

3174 Sunset Ave., Norristown, PA
19403, Phone: (800) 523-0702

Storage Devices, Inc.

PO Box 58234, Webster, TX
77598, Phone: (800) 835-3023

Syntax

18535 E. Gale Ave., Industry, CA
91748, Phone: (800) 552-8900

Telemart

8804 N. 23rd Ave., Phoenix, AZ
85021, Phone: (800) 537-4735

TriState Computer

160 Broadway, New York, NY
10038, Phone: (800) 433-5199

US Turbo Sys. & Comp.

1819 N. Floradale Ave., South El
Monte, CA 91733, Phone: (818)
579-2405

USA Flex

135 N. Brandon Dr., Glen Ellyn, IL
60139, Phone: (800) USA-FLEX

Verticom Corp.

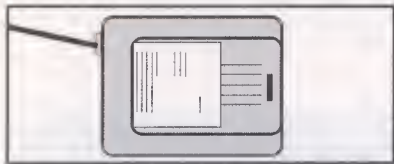
2810 NW 72nd Ave., Miami, FL
33122, Phone: (800) 345-4891

Warehouse 54

2415 S. Roosevelt, Tempe, AZ
85282, Phone: (800) 735-0054

WorldWide Tech

21 South 5th St., Philadelphia, PA
19106, Phone: (800) 457-6937



Practical PostScript Applications

Use This Simple Program to Create Signs With Tear-Off Strips

Have you ever had a car you wanted to sell or an apartment you wanted to rent? If so, you've probably spent a considerable amount of time making up signs to post in your neighborhood. Now, with this simple PostScript program, you can automate the production of these signs and also add the convenience of tear-off strips that contain all of the essential information. The advantage of these strips is that people don't pull your whole sign down, preventing others from seeing it, when they're too lazy to copy down the information they need. This program will print out two of these signs per page.

As you may be aware, PostScript is a stack-oriented language. A stack is an area of memory into which information is placed and retrieved on a last-in, first out basis. An easy way to think of a memory stack is to visualize the dish stackers used in restaurants that pop up a new dish each time the top one is removed. If you had a stack of white dishes on one of these, then placed a red dish on top and then two more white dishes on top of that, in order to retrieve the red dish, you'd first have to remove the two white dishes on top of it. The same is true for PostScript. Information is temporarily stored on the stack and then retrieved as needed.

Oops!: If you had trouble printing the program last issue, you're not alone. See Letters to the Editor on page 8.

The reason I mention this is that by grouping everything together at the beginning of the program, data for the sign is easier to enter and change. If the text were entered where the program actually needs it, it would be scattered all over the file. or convenience, I've divided the text into two categories: the main descriptive text which is currently designed to be five lines long (you can change this if you want by adding extra lines of text and extra line variables e.g. line8, line9, etc.) Lines of text to be printed must be within a set of parentheses.

When the program is run (sent to the printer), the printer's PostScript interpreter takes each line of text and stores it in memory, with the last line to be stored, being the first one that's available for use. The program then pulls each line of text off the stack and assigns it to a variable. In this case I chose variable names that represent the line number of the text (line1, line2, etc) but you can use any name you want instead. The first line pulled off the stack is line 7, the last line of text. It is assigned to a variable by the statement:

```
/line7 exch def
```

In a similar manner, the other lines of text are also assigned to variables.

The next thing the program does is define two new commands: **center** and **font**. The first centers a line of text about the current cursor location and the second just makes it easier to specify the particular font you want

to use when printing.

The heart of the program follows. It's a subroutine called **forsale** and it is designed to print out one copy of the sign on the top half of the page. The subroutine starts out with the **gsave** command which saves the current graphic state of the printer so that it can be restored later with the **grestore** command. By the way, it is very important that you realize that PostScript is case sensitive. So if something is written in lowercase letters, don't change it to uppercase. The handy feature about the **gsave** command is that you can translate the origin as much as you want to make it easy to implement your routine and when the **grestore** command is encountered, the origin goes back to where it was. This eliminates the need to keep track of where the exact position of the origin is so that you can back track, a real time saver.

One of the first things that the program does is position the cursor and print the first line of the headline in a 30-point, Times Roman Bold typeface. This line of text and the next one, will both be centered and take advantage of the **center** command that was previously defined. The **center** command is used frequently and should be part of your library of basic routines that are included in your programs. After the center command is the **show** command which is the PostScript instruction that actually does the printing.

POSTSCRIPT PROGRAM LISTING: FOR SALE

```

% Detailed descriptive copy for large portion of sign (5 lines)
%
(CAR FOR SALE)
(1981 Dodge Diplomat Salon)
(67,000 miles, power steering, power brakes, automatic)
(transmission, AM/FM radio, air conditioning, excellent.)
(condition, gas and maintenance log, $1250. Call 718-222-1234.)

% Summary descriptive copy for tear-off slips (2 lines)
%
(CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000)
(miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234)

/line7 exch def
/line6 exch def
/line5 exch def
/line4 exch def
/line3 exch def
/line2 exch def
/line1 exch def
/center { dup stringwidth pop 2 div neg 0 rmoveto } bind def
/font { findfont exch scalefont setfont } bind def

% Build a subroutine to print one sign

/forsale { gsave
  0 117 translate
  % Print primary headline
  30/Times-Bold font
  306 640 moveto
  line1 center show

  % Print secondary headline
  306 610 moveto
  0 12 translate
  24/Times-Bold font
  line2 center show
  0 7 translate

  % Print detailed descriptive text
  gsave
    /print { show 0 -16 translate 0 0 moveto } def
    14/Times-Bold font
    110.25 570 translate
    0 0 moveto
    line3 print
    line4 print
    line5 print
  grestore

  0 4 translate
  0 520 moveto
  612 0 rlineto stroke
  0 -72 translate

  % Print summary text on 13 tear-
  off strips
  612 0 translate
  90 rotate
  324 0 translate
  /print { show 0 -14 translate } def
  /x 18 def
  /y 580 def
  /y1 566 def
  /y2 556 def

  10/Times-Bold font
  13 {
    x y moveto line6 show
    x y1 moveto line7 show
    x y2 moveto 249 0 rlineto stroke
    0 -44 translate
  } repeat
  1 setgray
  0 44 translate
  x y2 moveto 249 0 rlineto stroke
  grestore } def

% Print the top half of the page
0 0 moveto
forsale

% Print the bottom half of the page
0 -396 translate
0 0 moveto forsale

showpage

```


CAR FOR SALE

1981 Dodge Diplomat Salon

67,000 miles, power steering, power brakes, automatic transmission, AM/FM radio, air conditioning, excellent condition, gas and maintenance log, \$1250. Call 718-222-1234.

CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
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CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234

CAR FOR SALE

1981 Dodge Diplomat Salon

67,000 miles, power steering, power brakes, automatic transmission, AM/FM radio, air conditioning, excellent condition, gas and maintenance log, \$1250. Call 718-222-1234.

CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
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CAR FOR SALE, 1981 Dodge Diplomat Salon, 67,000 miles, PS, PB, AT, A/C, AM/FM. Call 718-222-1234
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After these two lines are printed, a new subroutine, designed to print the descriptive text is used. It starts with the next **gsave** command. In order to minimize the PostScript coding and make printing those lines a little easier, I've defined a new command, called **print**, which issues the PostScript **show** command and then does the equivalent of a linefeed and a carriage return. It is commonly accepted practice to implement a linefeed by lowering the cursor's vertical position by 2 points more than the type size being used. In this case, we're using 14 point type, so we

drop the cursor 16 points. You can, however, do whatever you like. If you want to squeeze more type on a page you could drop only 13 points. If you want to open it up and make it easier to read, you can drop it 17 or 18 points. Notice that we're moving the cursor by moving (translating) the origin. This makes it possible to write a general purpose routine rather than one that is tied to specific locations on a page. By the way, the equivalent of a carriage return is implemented by issuing the 00 moveto command. After the main descriptive text is printed, a horizontal line is printed to

separate the main text from the tear-off strips. Then two commands are issued (**612 0 translate** and **90 rotate**) that effectively rotate the page by 90 degrees so the vertical running text on the tear-off strips can be printed. The cursor is then positioned to print out the first strip. Variables **x**, **y**, **y1** and **y2** are set up to define the locations of the first and second lines of text in the strip and the location of the vertical line (now horizontal) that separates them. You could just as easily have not used variables and used specific numbers because additional strips are going to be printed by relocating the origin. When I first put this program together, however, I anticipated a little more complex structure, hence the use of variables.

The strip is printed repetitiously by using the equivalent of a BASIC **FOR...NEXT** loop. In PostScript, the material to be repeated is preceded by the a number representing the number of iterations. Then the whole procedure is enclosed in braces. After the closing brace, the word "repeat" is used. In our case, we're doing 13 iterations where two lines of text are printed and a line is drawn.

For the last strip, we don't want the final line to appear. So after it is drawn by the routine within the loop, we go back and re-draw it again, except this time in white, effectively erasing the line. This ends our **forsale** routine, so we end it with a closing brace and the word **def**.

To use the program we've just created, we have to invoke it. This is done by simply typing the name of the subroutine. This prints a sign on the top half of the page. If we now relocate the origin so that it's vertical coordinate is half a page lower and then issue the the **forsale** command again, we can print the second sign. Finally, the **showpage** command is issued to eject the page from the printer. ■

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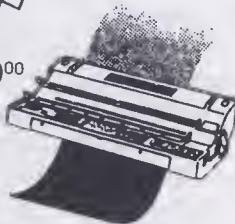


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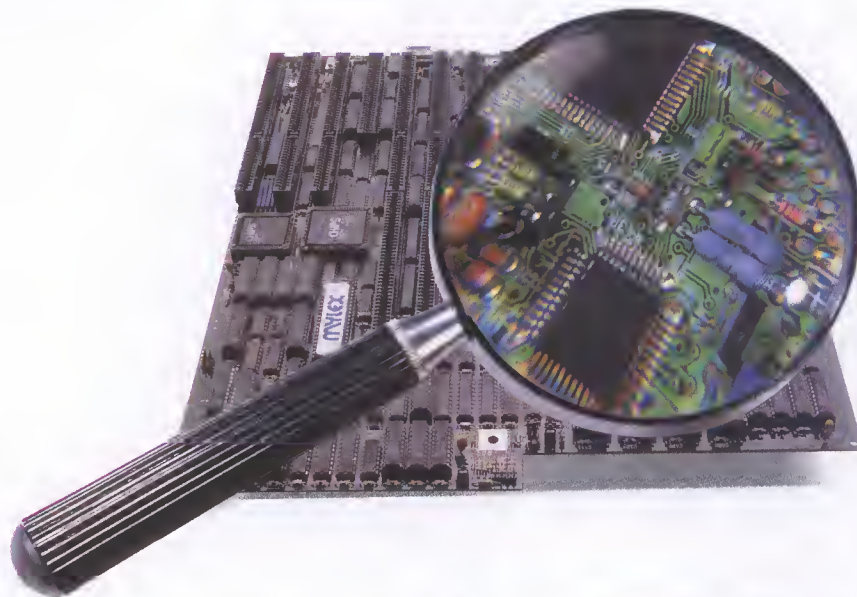
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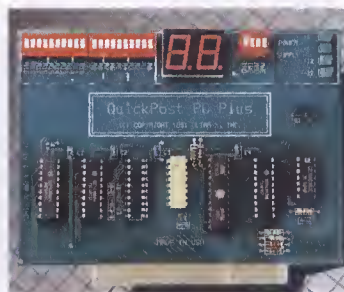
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